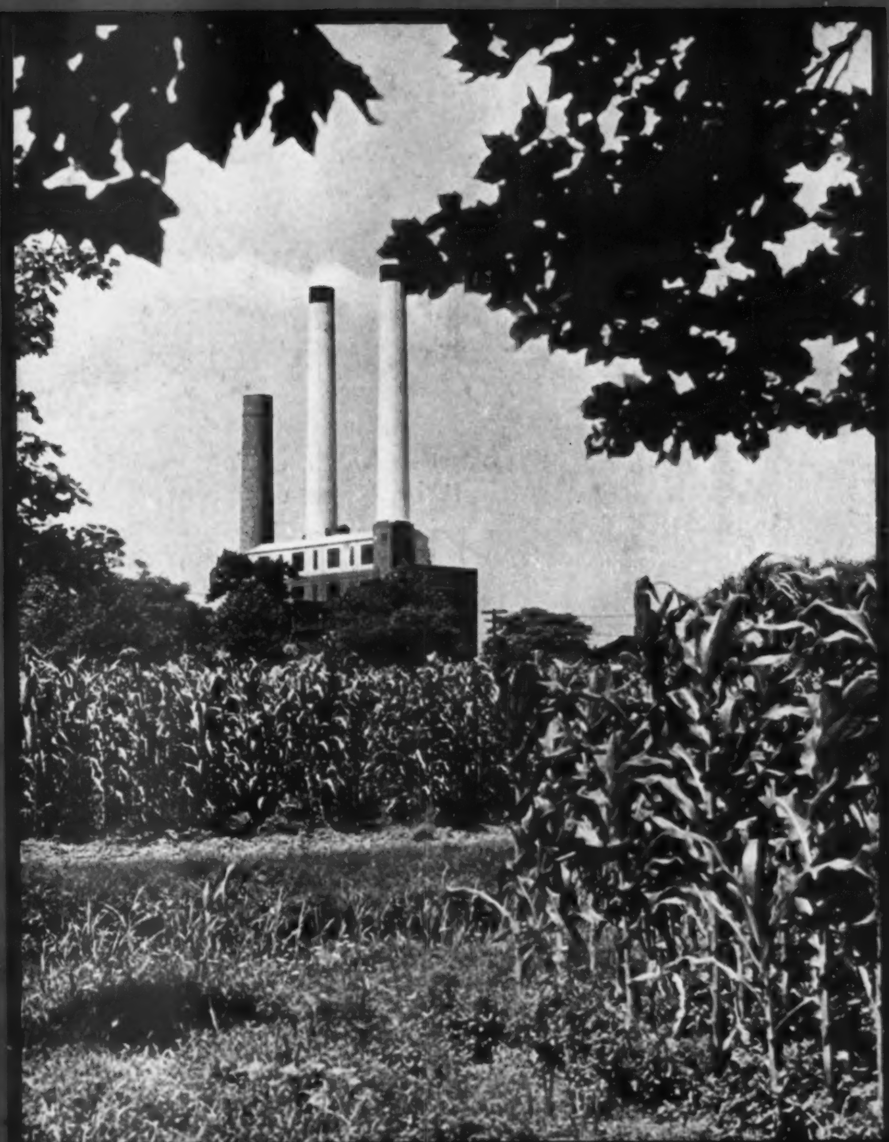
COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

October, 1942



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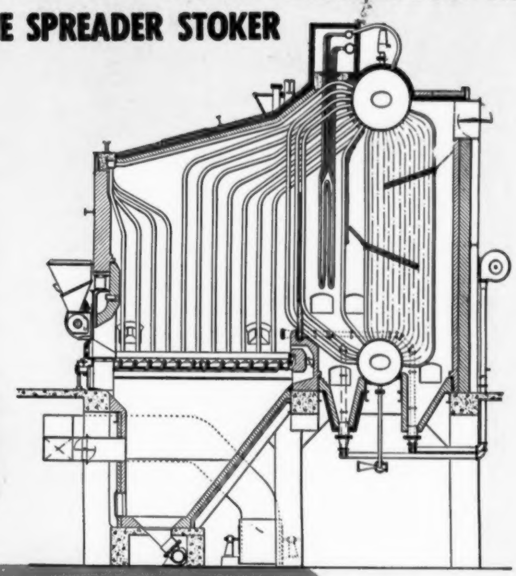
Low-Draft-Loss Dust Collectors ▸

Save Materials on Piping Design ▸

Ways to Avoid High Stoker Maintenance ▸

Combustion Engineering's *Standardized* VU STEAM GENERATOR

TYPE VU-Z STEAM GENERATOR *with* C-E SPREADER STOKER



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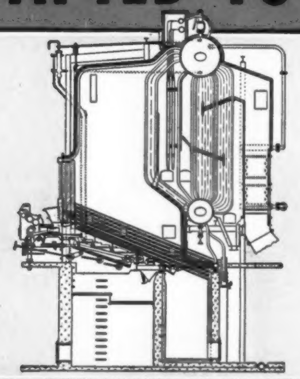
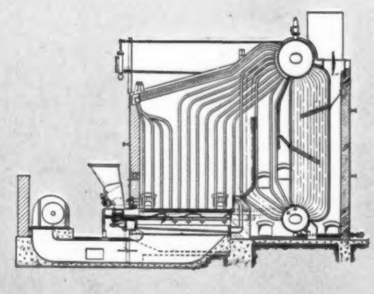
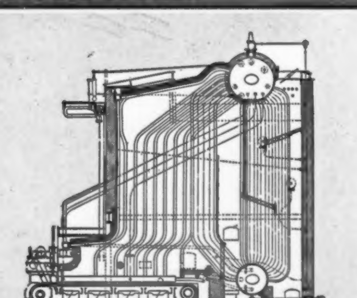


with C-E MULTIPLE RETORT STOKER



with C-E TYPE E STOKER



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COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

VOLUME FOURTEEN NUMBER FOUR

CONTENTS

FOR OCTOBER 1942

FEATURE ARTICLES

Low-Draft-Loss Flue-Dust Collectors at Conners Creek Power House .... *by H. E. Macomber* *30*

The Facts Concerning the Fuel Oil Situation *36*

Inspection and Maintenance of Superheaters .... *by F. I. Epley* *39*

Save Material on Piping Designs .... *by H. F. Behrens* *40*

Some Ways to Avoid High Stoker Maintenance .... *by A. R. Mumford* *43*

Two Hundred Register at Sixth Annual Fuels Conference *49*

EDITORIALS

A Rational Application of Censorship *29*

Conversion *29*

DEPARTMENTS

Facts and Figures *38*

Review of New Books *51*

Equipment Sales *54*

New Catalogs and Bulletins *55*

Advertisers in This Issue *56*

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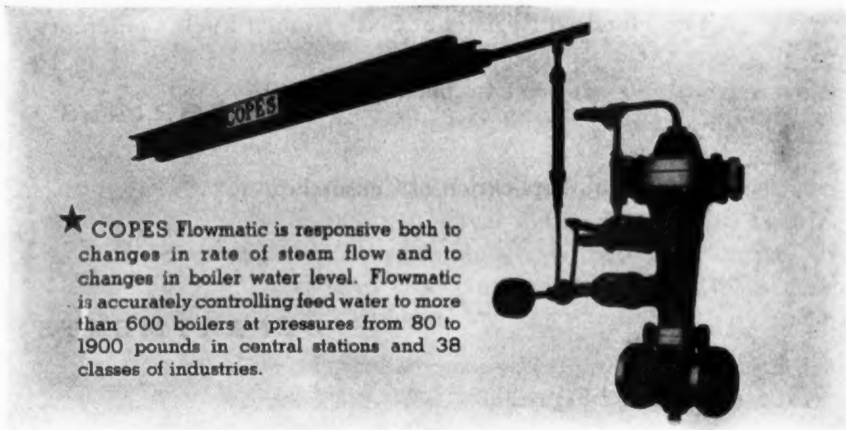

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EDITORIAL

A Rational Application of Censorship

Less strict censorship on the results of scientific research is urged in the annual report of the Welding Research Committee of the American Welding Society. In the opinion of Col. G. F. Jenks, President of that society, "The greatest benefits to war production and to victory in the field will accrue from a liberal policy through which the results of research will be disseminated immediately to American engineers and scientists."

The technical press is the media through which such progress in various fields can most speedily be made available to those engaged in pushing war production. It is believed that this fact is appreciated by the Government, but inasmuch as most technical magazines have some foreign circulation within the allied and neutral countries, not adjacent to the Axis nations, the tendency has been to exclude most of such information on the theory that some might filter through to our enemies. Granting this possibility, there are many who contend that the advantages to our war effort would far outweigh any chance benefit to the enemy.

The necessity for present restrictions on the publication of power plant data and photographs has sometimes been questioned in view of the fact that detailed information and views of many of our outstanding stations were contained in pamphlets freely distributed to foreign delegates at the last World Power Conference in 1936. Also, the Government itself, until shortly before our entry into the war, made available many pamphlets and reports containing data and maps showing the locations, capacities, etc., of our large power stations and transmission systems. All these were accessible to our present enemies.

The task of imposing censorship on technical information is a difficult one to administer. It has been necessary to prescribe certain broad principles within which there is certain latitude for the application of discretion. One difficulty has been in securing personnel familiar with all phases of the various fields. Hence, the tendency of some of those charged with the responsibility of censorship has been, when in doubt, to play safe by questioning or deleting anything which to them appears new. This has led to inconsistencies in matter released. Nevertheless, credit must be accorded most of the censors for conscientious effort.

Technical magazines, as in the case of the daily press, are charged with the responsibility of self-imposed censorship, and it is believed that such editors and publishers can be depended upon to take this responsibility seriously. Technical editors are sufficiently conversant with developments in their respective fields, both at home and abroad, to enable them to judge what information, within the prescribed censorship rules, might be of assistance to the enemy. Hence, government censors might well rely, to a greater extent than at present, upon this specialized knowledge and judgment, fortified by the patriotism of the editors concerned.

In some cases, managements, to a greater extent than the censors, have leaned over backward in order to avoid any possibility of releasing information that might be construed as trespassing on regulations. Often this results from lack of familiarity with what is and what is not permissible under the rules.

Conversion

According to reports from the Petroleum Coordinator's office, conversion from oil to coal has progressed much further among industrial establishments than among domestic consumers. In fact, until the recent rationing plan of fuel oil for heating was announced, there existed considerable complacency within the latter group. Rationing and the prospects of some discomfort with the advent of cold weather will undoubtedly serve to bring about a fuller realization of the situation.

As regards industrial plants, the contemplated survey by the Government to determine those that can be readily converted, those that can be converted at reasonable expense and little effort and those where it is impracticable should result in a considerable increase in the present percentage of conversions. However, much will depend upon the manner in which such a survey is conducted. If by questionnaire, the results are likely to be less satisfactory than if conducted by personal inspections. In the latter event those selected to make plant visits should be qualified by experience to determine the feasibility of conversions and to offer constructive suggestions.

In some cases it may be argued that the materials and labor involved are such as to make conversion inexpedient. However, in a period such as the present, desirable layouts must often give place to makeshifts in order to save materials, lest the purpose be defeated through inability to obtain priorities for the more elaborate plans. Although many plants that had previously changed from coal to oil subsequently utilized coal-storage space for other purposes, this is seldom a valid bar to reconversion as other space, even if less suitable, can usually be found for coal.

There appears to be a feeling among the managements of certain plants engaged in war production that the Government will see to it that they are supplied with oil, regardless of developments. Whether or not this assumption is well founded, the attitude is wrong. Many of these plants are large consumers of oil and their conversion would offer a substantial contribution to conservation. Moreover, the character of their work would insure high priority for the necessary equipment and they could better afford the expense than many smaller plants in the non-essential group. The latter, however, may well regard the money spent in conversion as insurance against shutdown if the situation should later become more acute.

Low-Draft-Loss Flue-Dust Collectors at Conners Creek Power House

By H. E. MACOMBER
The Detroit Edison Company

A description of the development work leading up to the present design of wedge-type flue-dust collector, operating on the Van Tongeren principle, which is installed on five of the stoker-fired boilers. Test results are included.

A SERIES of articles by Sabin Crocker in COMBUSTION, extending from November 1935 through June 1936, described in detail the rebuilding work which had been carried on at the Conners Creek Power House of The Detroit Edison Company.

In carrying forward the project at the time, the decision was made to utilize the building structure and stacks which had been in use since the original plant was placed in operation in 1915. The stacks had been used as the lone source of draft to handle the flue gases, each stack with a height of 325 ft above the stoker grates serving two boilers with a total steaming capacity of about 325,000 lb per hr.

When the plant was rebuilt, the new steam generators were designed to fit within the spacing of the original boiler columns but, because of the additional capacity required per unit, the overall height was necessarily considerably greater than the height of the original boilers due, for the most part, to the use of an economizer, air preheater and induced-draft fan. It was also decided to continue the use of the original stacks to serve, in part, the draft requirements of the new steam generators. As finally worked out, each new unit was installed as shown in the sectional elevation, Fig. 1. There are eleven of these steam generators in the rebuilt plant and each has a nominal full-load rating of 330,000 lb per hr at 650 lb per sq in. pressure and 850 F, and a maximum load rating of 420,000 lb per hr.

As will be seen in Fig. 1, these units are fired with double-ended underfeed stokers and, in order to keep the overall height down as much as possible, the flue-gas circuit, after leaving the boiler, divides into two parallel circuits in passing through the economizers and air preheaters.

The induced-draft fan for each steam generator is a fan with double-inlet and double-suction entrance, and is designed to develop a static pressure of 15.45 in. of water while passing 186,000 cu ft per min of gas at a temperature of 370 F. The flue gas, upon leaving each of the twin air preheaters, is again divided and passes through short connecting elbows to enter the fan inlet boxes located at either end of the wheel. Between the fan and the stack base there is a short diverging duct to aid in conversion of velocity pressure of the gas to static pressure.

Based upon past experience in the operation of stoker-fired boilers, it appeared at the time of replacing the old steam generating equipment, to be unnecessary to consider making special provisions for flue-dust collecting equipment. Of course, a similar decision would not have been made if pulverized-coal fuel-burning equipment had been selected.

That is, in the past the pulverized-coal-fired unit generally had been considered to be a greater offender than the stoker-fired unit in amount of fly ash (flue dust) emitted from the stack, chiefly because the coal upon admission to the pulverized-coal-fired furnace is already finely ground and is carried in suspension in the combustion air. On the other hand, the condition of the fly-ash discharge from the stacks of most of the recently constructed stoker-fired boilers has become quite critical for the reason that the improved efficiency of utilization of steam at the higher pressures and temperatures supplied by such units usually justifies their operation at near maximum output.

Dust Loadings With Stokers and With Pulverized Coal

The following is to be considered here as applying to the stoker-fired boiler and results as determined by test: Whereas dust loading of flue gases from a pulverized-coal-fired unit will vary approximately in the ratio of 1 to 1.5 for an increase of boiler load from 50 per cent to 100 per cent of full load, that discharged to the stack from a modern stoker-fired unit, capable of burning coal at rates approaching 75 lb per sq ft of grate per hour, will vary as about 1 to 12 for a similar range of load, and in the ratio of perhaps 1 to 10 in terms of material borne by the flue gases when leaving the furnace.

In the present instance this thought was borne out as the result of ash balance tests conducted on one of the new Conners Creek steam generators. In these tests it was determined that, at a fuel-burning rate of 75 lb per sq ft of grate, up to 53 per cent, by weight, of the ash in the coal (exclusive of combustible) was carried from the furnace by the flue gases. In terms of flue dust, or ash plus combustible, the total dust carried from the furnace was nearly 10 per cent, by weight, of the coal fed to the furnace. Of this amount, approximately 60 per cent consisting of the larger particles of dust, or cinder, was trapped in the pass hoppers. In Fig. 1, these hoppers are shown at the bottom of the second and fourth passes on either side of the boiler just below the bottom drums, and as the connection between each economizer and air heater.

Later, too, it was determined that, depending upon the condition of the fuel bed, the total carry of dust from the furnace might even exceed 10 per cent by weight of the coal fed to the furnace.

A study of various types of mechanical flue dust collectors which might be adapted to the Conners Creek

installation was begun in 1937. There were a number of factors to be considered but principally these resolved to: (1) a question of minimum cost of field erection (that is, least expense for alteration of building structure and connection to the flue gas circuit); and (2) the question of minimum draft loss in order that maximum output

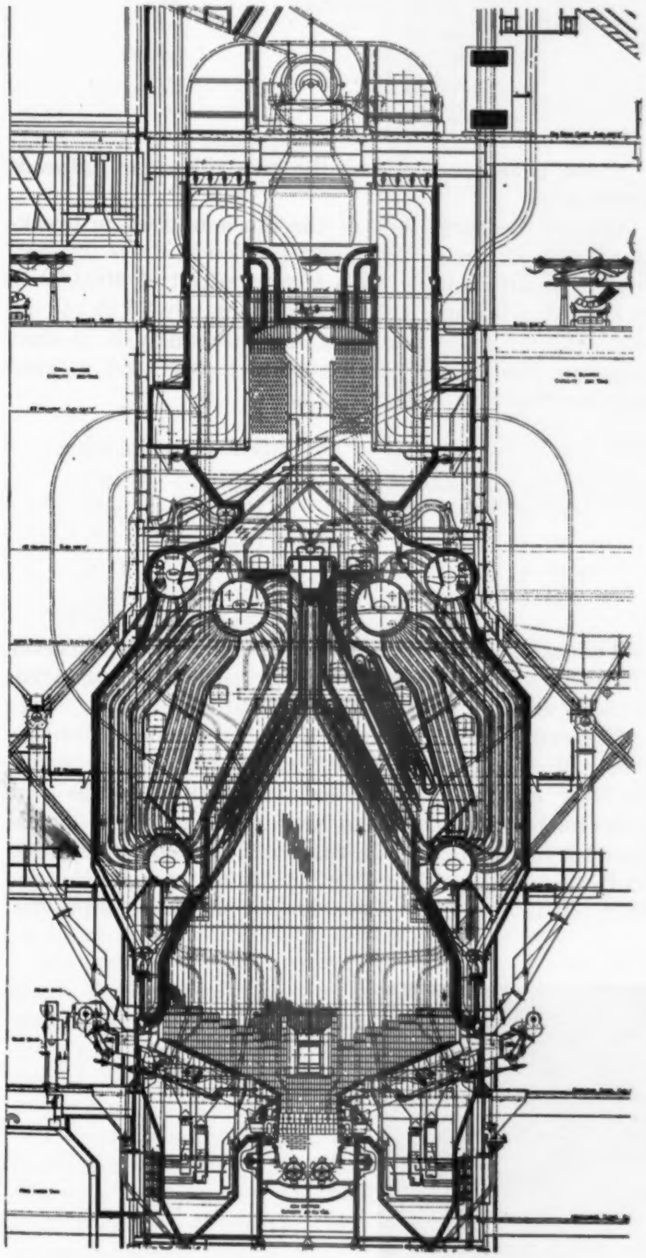


Fig. 1—Cross-sectional elevation of present Conners Creek boiler

of the steam generator would not be penalized unduly because of the additional load which necessarily would need to be carried by the induced-draft fan. In both cases, certain restrictions were adopted which were to be met by the manufacturers. These were, in the case of (1), that the collector must adapt itself to space available within the building at the fan-room floor elevation, and, in the case of (2), that the additional draft requirements of the collector over the requirements of the existing duct connections at maximum load should preferably be less than one inch of water.

It was realized that, to meet these requirements, we would have to be satisfied with an overall efficiency of collection less than values ordinarily associated with certain types of collectors—that is, 90 per cent or over. However, in this case, it was the opinion that a collector providing an overall collection efficiency of the order of 75 to 80 per cent would result in a stack emission which would not be considered as a nuisance.

Flue dust consists of a range of particle sizes, from the very small—perhaps one micron—up to the largest which may be borne at the existing velocity of the flue gas in the stack, providing particles of such a maximum size are present. Both the quantity and sizes, as well as the distribution of sizes, vary with any installation according to the method and rate of operation. There is, for example, a wider range of particle size variation resulting from operation of stoker-fired equipment than of pulverized-coal-fired equipment and, of course, a distinctly different proportioning of sizes. In general, stoker fly ash is proportioned as about 75 per cent plus 325 mesh, or 43 microns in size, while pulverized-coal fly ash is proportioned about inversely as those values.

The removal of particles in sizes exceeding 325 mesh is possible at an efficiency of 90 per cent or more with the use of almost any collector commercially available. Under average conditions of operation with stoker-fired equipment, the removal of 90 per cent of the plus-325-mesh material would account for not only 67.5 per cent of the total dust, but actually for more than that amount—perhaps as much as 75 per cent of the total. This is true for the reason that any collector capable of removing particles of plus-325-mesh size at good efficiency, will also remove particles of minus-325-mesh size, although at a decreasing efficiency of removal as the particles become smaller. The point to be stressed here is that a nuisance may be abated by use of a collector capable of removal, in good proportion, of the plus-325-mesh material in those cases where a major proportion of the total fly ash falls within that range. Such a condition usually occurs with stoker operation.

As a result of investigation of various types of equipment which were available for installation at Conners Creek, the Wedge-Type Collector offered by the Buell Engineering Company under the Van Tongeren patents seemed best to meet the requirements of space, draft and cost and, as well, according to the guarantee, provide an overall collection efficiency of an order which would eliminate the stack discharge as cause of a nuisance.

This collector derives its name from the shape of the primary element which is used to divert the air- or gas-borne dust from the main stream of gas after which the dust is bypassed, or shunted, as a concentrated mixture with a small portion of the gas to a highly efficient centrifugal collector for final separation. The major portion of the gas in the meantime passes through the wedge and continues on as clean gas to the point of disposal—in this case the stack.

The wedge is usually built in the shape of a "V" with the apex or nose pointed upstream facing the flow of gas. The wedge can be installed in a straight or diverging piece of duct and is built somewhat as a picket fence with the "pickets" formed by $^3/_4$-in. extra-heavy pipe bars placed on $1^3/_8$-in. centers and with the longitudinal axis of the bars perpendicular to the axis of the duct. At the downstream or rear end of each side of the wedge, where the wedge approaches the side walls of the duct, narrow

outlet openings are provided through which the dust is carried to the secondary collector or cyclone as mentioned previously. The quantity of gas bypassed to the cyclone, as the carrier for the dust, is essentially a constant volume irrespective of the volume approaching the wedge. Generally, however, the volume passed to the cyclone is of the order of 10 or 12 per cent of the maximum or rated capacity of the wedge. An auxiliary fan is used in the bypass circuit to overcome the added resistance of the cyclone. The fan is placed on the clean gas side of the cyclone and discharges the bypassed gas back into the main stream following the wedge.

The first offering of this collector by the manufacturer was concerned with placing the collector to form the diverging outlet duct between an induced-draft fan discharge opening and the stack. The wedge was about 14 ft long, the wedge casing at the entrance next to the fan 5 by 5 ft, and at the outlet end next to the stack it was 8 ft 6 in. wide by 8 ft high. Two cyclones of 10,000 cu ft per min capacity each were to be used and the gas and dust bypassed from the wedge unit to the cyclones was to be handled by two fans of like capacity, developing 3 in. of water static pressure and driven by constant-speed 15-hp motors.

Consideration was given to installation of the collector at the inlet side of the induced-draft fan but the idea was temporarily discarded because of the space limitations imposed by the closeness of the induced-draft fan to the air preheater outlets.

A wedge-type collector was installed with one boiler between the fan and stack in the fall of 1939. It was tested after installation and, although the overall collection was less than guaranteed, the collection according to particle-size efficiency was satisfactory and the draft loss was within the specified limits. The cause of the discrepancy was that the guarantee for total collection efficiency had been proposed on the basis of the size distribution of a typical sample of dust taken from the inlet side of the induced-draft fan; that is, the possibility of breakdown of particles of dust in passing the fan and the resulting penalty on overall collection had been overlooked.

The size distribution of a typical sample of flue dust used to compute the possible total collection efficiency was:

+ 70	Microns	50%
−70 + 40	"	25%
−40 + 30	"	15%
−30 + 20	"	5%
−20 + 10	"	5%

These values occurred on the inlet side of an induced-draft fan.

On the discharge side of the fan a noticeable breakdown of particles seems to occur at loads above one-half load. As an example, at a steam output of 400,000 lb per hr, or a burning rate of approximately 75 lb of coal per sq ft of grate per hour, the size analysis of dust entering and leaving the fan which operated in conjunction with this collector was:

		Entering	Leaving
+ 70	Microns	52%	34%
−70 + 40	"	14%	20%
−40 + 30	"	7%	8%
−30 + 20	"	8%	11%
−20 + 10	"	10%	14%

The sizing of these samples of flue dust, and wherever else in this article data of a similar nature are presented, is the result of analysis by air elutriation.

Following the acceptance of the first collector on the basis of particle-size collection efficiency the manufacturer was again requested to adapt a wedge-type collector to the inlet side of the fan. That is the logical location for the reason that fan-blade erosion is retarded and, assuming performance according to particle size to be equal, total collection efficiency should be improved.

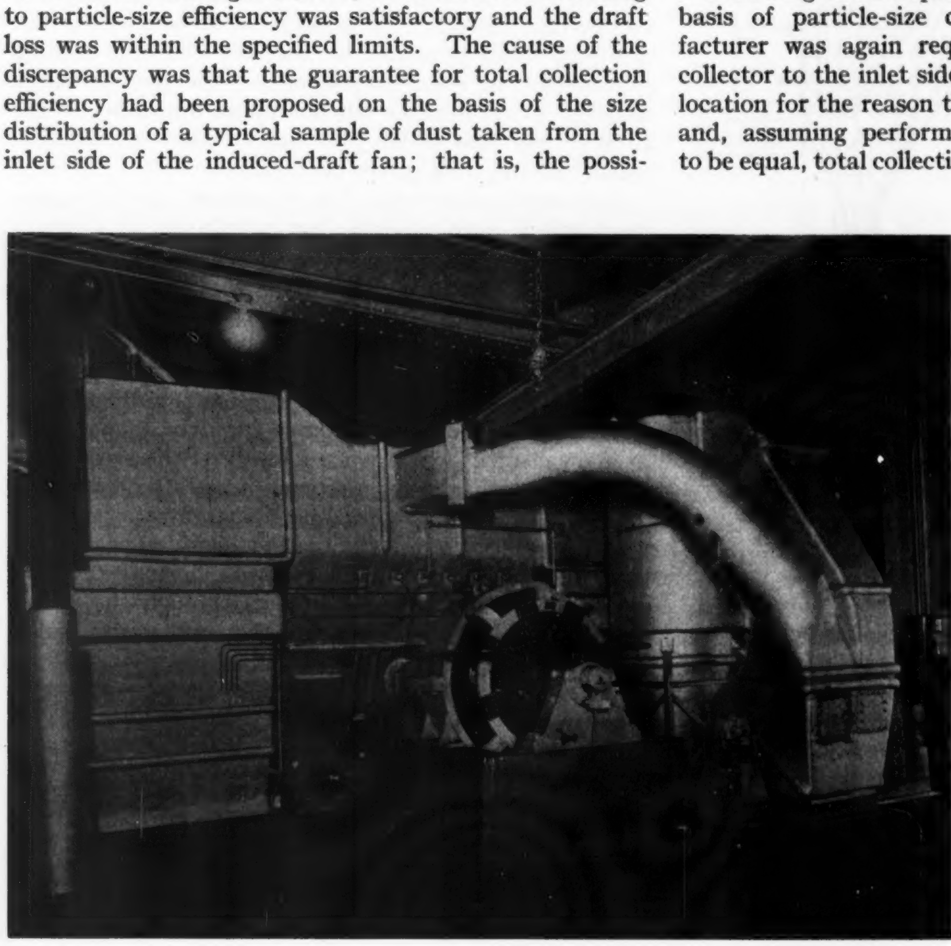


Fig. 2—Induced-draft fan with flue-dust collector assembly, showing cyclone at right and wedge casing at left

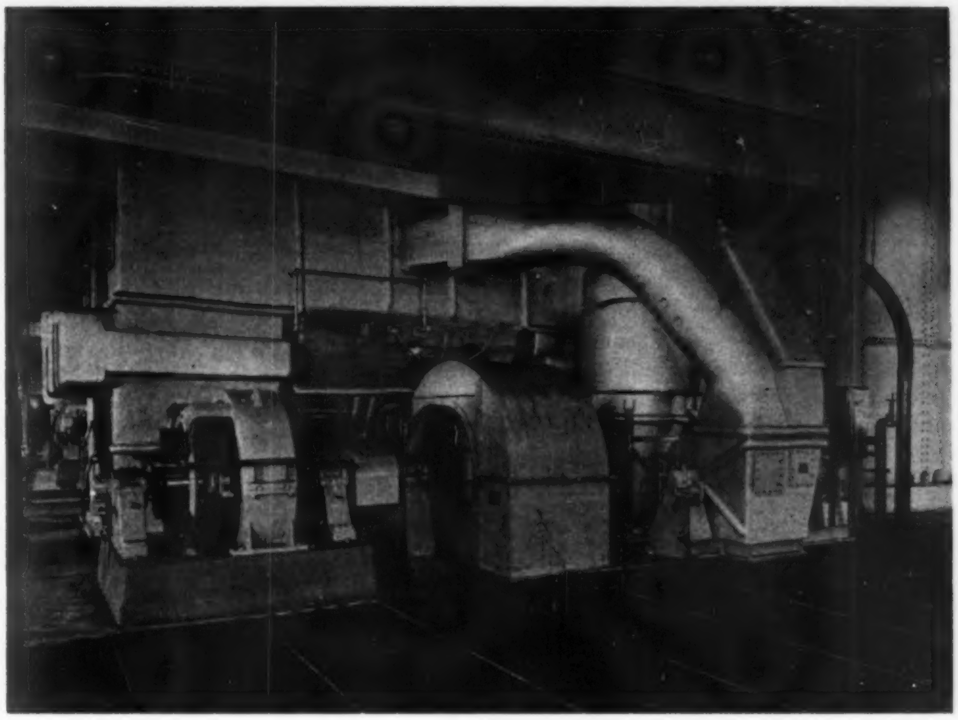


Fig. 3—View of dust-collector assembly with forced-draft fan in foreground

Following considerable study of the matter by the manufacturer and by the Company, a design was arrived at whereby four smaller wedges and casings were to be installed to replace the inlet duct elbows previously used as connection pieces between the air preheaters and the induced-draft fan inlet boxes. The bypass gas and the dust from the two wedges serving one preheater were to be combined in a manifold and drawn to one cyclone. The two cyclones for the job duplicated those of the first installation but the auxiliary fans were ordered on the basis of developing 3.5 in. static pressure and were driven by 20-hp motors.

Limitation of space made it necessary to sacrifice some design dimensions in the proportioning of the wedges which were placed in a position for vertical flow of inlet gas from the air heaters into the wedge and horizontal discharge from the wedge to the fan-inlet box at each corner of the fan.

The manufacturer's guarantee was the same as proposed for the first collector, based on size efficiency. However, on test, these inlet collectors failed to meet the guarantee by a considerable margin when based on comparable size efficiencies. On the basis of total collection the discrepancy was not as great. This, of course, was because the collector handles the dust before it is subjected to breakup in the fan.

The contributing causes to this condition seemed to be improper proportioning of the wedges, bypassing of part of the wedge vane surface due to the gas having to turn a corner from entrance to exit of the wedge, and, to some extent, the poor distribution of gas flow and dust loading of the flue gas. The wedges, although operating in parallel with apparently symmetrical gas circuits through the economizers and air heaters, did not handle equal quantities of gas and dust. The dust catch from one unit on a fan (two wedges and the accompanying cyclone) was nearly twice the catch from the other pair of wedges and cyclone of the same induced-draft fan.

Subsequent to installation and test of the first two inlet collectors, the procedure offering the most promise of improvement seemed to involve revision of the wedge dimensions to provide for more desirable proportions of wedge-vane area to inlet-duct area and to revise the wedge outlet so as to permit straight-through flow of the gas. This design required closing up the present inlet-box entrances and necessitated new entrances into the tops of the fan-inlet boxes. As far as inlet-box design is concerned this is not unusual.

Collectors of this revised design were installed on the inlet side of two induced-draft fans early in 1942. The location of the cyclones and auxiliary fans and the arrangement of the bypass manifolds and connection ducts nearly duplicate the arrangement for the first two inlet-type collectors.

Externally these collectors appear as shown in Figs. 2 and 3. Referring to Fig. 2, the photograph shows a side view of the induced-draft fan with the driving motor in the center foreground and the diverging fan discharge duct to the stack at the upper left. At the right is seen one of the two cyclones and the corresponding auxiliary fan which draws the bypass gas through the cyclone and discharges to the inlet box of the induced-draft fan. At the left is shown one of the four wedge casings which connect the air heaters, just below the floor, to the top of the fan inlet box. The cyclone and auxiliary fan associated with this wedge and its companion may be seen in the opposite side view, Fig. 3. A general arrangement of the equipment is shown in Fig. 4. For comparative purposes, Fig. 5 indicates the appearance of an induced-draft fan as originally installed without a collector.

Following installation, one of the collectors was tested to determine its performance and efficiency. It was found to be satisfactory.

The procedure followed was the same as used in the previous tests concerned with the first wedge collector

installed on the discharge side of the induced-draft fan, and the second which was the first adapted to the inlet side of the induced-draft fan.

Briefly, the determination of efficiency of collection was arrived at through:

1. Weight of dust removed by the cyclones.
2. Weight of dust lost to stack as determined by sampling of the flue gases between the induced-draft fan and stack for dust loading; and total gas flow to stack.

Total gas flow was determined as the result of a heat-balance test of the steam generator.

The duct area at the point of sampling was 51.22 sq ft. The sampling section was at right angles to the plane of the duct and was divided into 30 equal areas. Samples were removed from the center of each area.

Test Apparatus

1. The flue dust removed by each cyclone was conveyed by gravity through a pipe to a sealed bin. As the dust-discharge pipe was under suction, it was necessary to valve off the bin during removal of dust from the bin for weighing.

2. Two null-differential-type sampling nozzles, 1 in. and $^3/_4$ in. in diameter, were used for sampling the gases. An Askania Minimeter connected differentially to the inner and outer static pressure openings of the nozzle was used as the regulating guide for the adjustment of the sampling velocity to the duct velocity.

The dust drawn off with the sample was removed from the gas by first passing the gas into a small cyclone and then through a paper filter. The sample gas volume was measured by use of a plate orifice.

3. Gas, steam and water temperatures were measured with calibrated thermocouples and potentiometers.

4. Gas flow bypassed from the wedge chambers to the cyclones was measured with round-nosed pitot tubes.

Test Procedure

1. The load in terms of steam flow was adjusted to the desired value two hours previous to each test run, and the dust removed from the collectors was cut over to the test bins.

2. Dust-laden samples of flue gas were withdrawn from the sampling section for a period of ten minutes at each of the thirty sampling points.

3. All miscellaneous readings were taken at fifteen-minute intervals during each test run.

Test Results

The results obtained in this test are shown in the table.

It will be noticed that this collector exhibits the characteristic of most mechanical collectors: decreasing efficiency of collection accompanying decrease of load. The cause in the present instance is, however, for the most part, due to the increased proportion of the smaller particle sizes found in the dust at the lower load.

However, fall-off in efficiency of the amount indicated cannot be considered a serious matter because it is also accompanied by the decrease in the dust-loading value of the flue gas as shown in Item 13. The aim in the installation of any dust-removal equipment for the purpose outlined in this article is to clear up a possible nuisance resulting from discharge of dust to the atmosphere—nuisance being measured in terms of the total dust emitted from the stack and to some extent in terms of the sizing of the dust. Here this condition is satisfied as noted, although a similar characteristic, as it concerns collection efficiency, might not be tolerated in

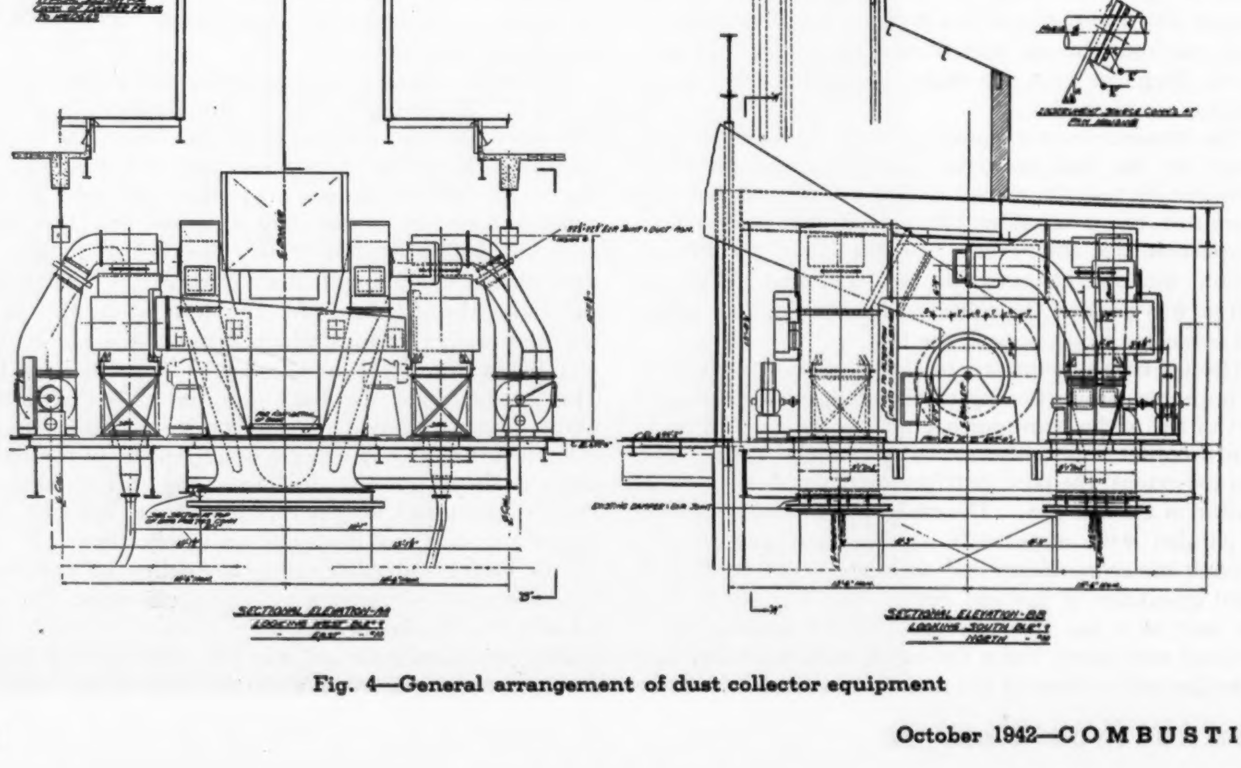
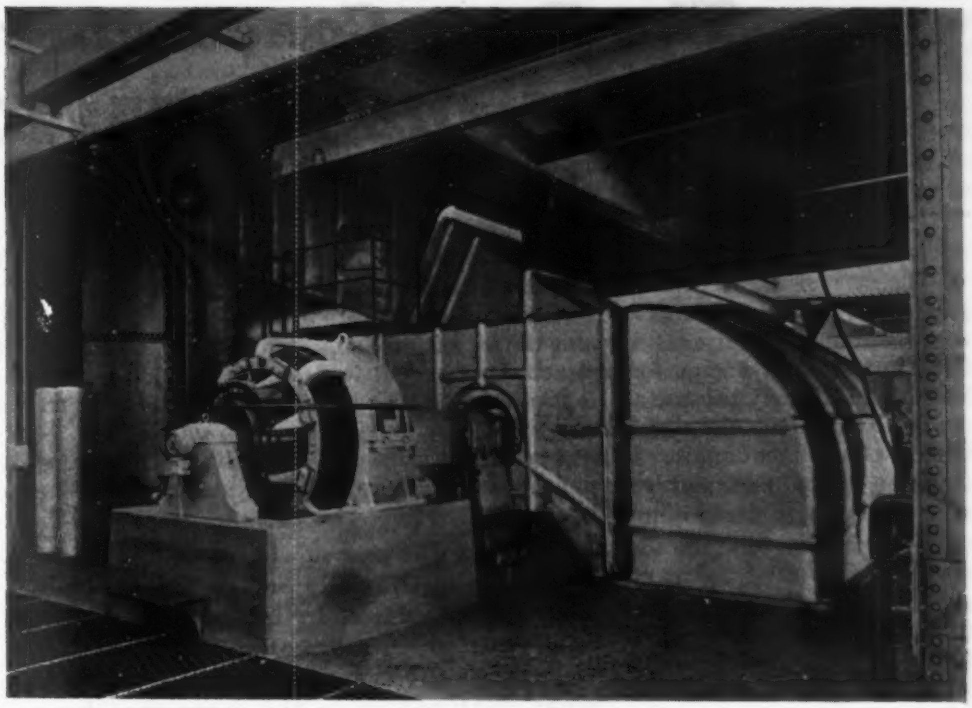


Fig. 4—General arrangement of dust collector equipment

Fig. 5—Original induced-draft fan without flue-dust collector



the case of pulverized-fuel-burning equipment because of the nearly constant dust loading of the flue gases, irrespective of collector load.

A comparison of the values recorded for induced-draft fan power, Items 21 and 22, shows a credit in favor of the test unit including the collector, except at the highest load. The latter was the result of a draft condition arising from diversion of flue gases in the boiler necessary for the regulation of steam temperature.

TABLE I

1. Test Number		4	1	3	2	
2. Date of Test		5/8/42	5/5/42	5/7/42	5/6/42	
3. Boiler Steam Output	Lb/Hr	156,900	237,900	308,700	382,600	
4. Coal Burning Rate	Lb/Hr	14,400	21,600	28,400	38,000	
5. Coal Burning Rate	Lb/Sq Ft Grate	25.8	38.7	51.0	68.2	
6. Dust Collected (Weighed)	Lb/Hr	29.9	174	757	2,033	
7. Escape Dust (To Stack) (By Samplers)	Lb/Hr	29.1	80	193	676	
8. Total Dust to Collector	Lb/Hr	59.0	254	950	2,709	
9. Actual Overall Collector Efficiency	Per Cent	50.7	68.6	79.7	75.1	
10. Estimated Overall Collector Efficiency (Based on Sizing of Typical Sample) See Item 23	Per Cent	73.8	75.0	86.2	90.7	
11. Actual Overall Collector Efficiency (Based on Particles Plus-20-Microns Size)	Per Cent	74.6	75.8	88.7	85.0	
12. Flue Dust to Collector (Per Cent of Coal Burned)	Per Cent	0.4	1.2	3.4	7.3	
13. Dust Loading of Flue Gases (Entering Collector)	Gr/Cu Ft	0.11	0.31	0.94	1.92	
14. Dust Loading of Flue Gases (Leaving Collector)	Gr/Cu Ft	0.05	0.10	0.19	0.48	
15. Flue Gas Flow	Lb/Hr	203,700	288,700	357,500	472,000	
16. Flue Gas Flow	CFM	63,100	94,000	118,100	164,200	
17. Flue Gas Flow (Total, 2 Fans) By-Pass Circuit to Auxiliary Fans	CFM	20,600	21,200	21,800	22,700	
18. Pressure Loss Through Cyclones	In. H_2O	2.2	2.2	2.2	2.3	
19. Auxiliary Fan Power (2 Fans)	Total HP	43.3	42.5	43.2	43.1	
20. Pressure Loss Through Collector (Including Ducting)	In. H_2O	0.7	0.9	1.1	1.4	
21. Induced-Draft Fan Power (Original Duct Connections, No Collector)	HP	70	176	313	620	
22. Induced-Draft Fan Power Present Collector and Top Connection to Inlet Boxes	HP	68.8	156.9	286.8	689.2	
23. Size Distribution of Flue Dust at Collector Inlet						Typical Sample
Size—Microns (All Particles +70)	Per Cent	40.0	56.0	44.0	57.0	50.0
−70 + 40	Per Cent	9.8	15.6	14.8	12.4	25.0
−40 + 30	Per Cent	4.7	6.4	8.3	6.0	15.0
−30 + 20	Per Cent	5.3	6.7	9.0	6.8	5.0
−20 + 0	Per Cent	39.8	15.3	23.9	17.8	–
−20 + 10	Per Cent	–	–	–	–	5.0
24. Fractional Efficiency Based on Actual Overall Efficiency and Size Distribution of Inlet Dust						Guarantee
Size—Microns (All Particles +70)	Per Cent	82.0	78.0	90.7	88.0	97.0
−70 + 40	Per Cent	78.3	77.0	88.0	84.0	93.0
−40 + 30	Per Cent	70.0	76.0	84.5	74.2	76.0
−30 + 20	Per Cent	44.1	72.5	78.4	65.8	59.0
−20 + 0	Per Cent	10.0	36.4	43.9	25.0	19.0

Disposal of Flue Dust

Disposal of the flue dust removed from the two cyclone separators associated with the collector is by gravity discharge through pipes to the hoppers of the two stokers from which it is re-fed with the coal to the fuel bed. Two weighted check valves placed in series in each pipe line afford an air-lock space and thus prevent back-flow of air while dust is discharged.

Introduction of the dust to the furnace is through six of the twelve retorts of each of the twin stokers. In this process the collector flue dust, together with cinder removed from the outer, lower-drum hoppers and economizer hoppers, is intermixed with the coal as the coal feeds from the spreaders to the stoker hoppers.

The remaining six alternate retorts of each stoker receive the cinder from the inner, lower-drum hoppers. This cinder is distinctly larger in particle sizing and in quantity than the cinder recovered from the outer hoppers.

This arrangement provides an essentially even distribution of dust and cinder to all retorts of the two stokers and, as well, provides for recovery of a large part of the heat represented in the combustible content of the dust and cinder.

At the present time five of the eleven steam generators in the plant are provided with collectors. The first, installed at the discharge side of a fan, will probably continue without change. The second and third, which constituted the first attempt at locating a collector at the fan inlet, will be remodeled at some future time to the design of the fourth and fifth units which are here shown.

The program contemplated called for the installation of collectors on two additional steam generators each year until all were equipped. For the present, however, the program has been halted as the result of the diversion of materials to war production.

The Facts Concerning the FUEL OIL SITUATION

THE OIL supply problem, which at first concerned chiefly the Eastern Seaboard and certain Pacific Coast regions, has now broadened to include the greater part of the country. Not only is it interwoven with the rubber shortage, as concerns the use of gasoline, but as a source of energy for producing power and for heating it has lately become acute. So many factors are involved that control of the situation is no easy matter, but the Government appears to be approaching it from a long-range standpoint and is attempting to handle it in such a way as to evoke minimum hardships, while at the same time assuring necessary supplies for the armed forces, war production and the needs of our allies. With our shipyards turning out ships for the Maritime Commission at the present unprecedented rate, and the huge naval program in full swing, marine requirements for fuel oil are piling up at an accelerated rate and these must be met.

Hardly a day passes without some items appearing in the daily press relative to the fuel oil situation. In fact, so much has been printed, in more or less fragmentary form, that the average individual is somewhat confused as to the facts that have necessitated the issuance of various governmental orders concerning this commodity that so closely affects our mode of living. The following notes are largely based on recent first-hand information gained through a conference with various individuals in the Office of Petroleum Coordinator for War. They are offered with the full understanding that conditions are likely to change from time to time because of certain unpredictable factors.

So far Russia has been getting much of her oil from the Caucasus and British forces in certain localities are being supplied from Iran and Iraq. Should the Axis succeed in gaining possession of the Caucasian oil fields and England be unable to maintain control of the fields in Iran and Iraq, it would then become necessary for the United States to assume the task of meeting the full needs of the Allied Nations. However remote, this is a situation that we must be prepared to meet should it arise, and present planning must take it into account.

In normal times about 95 per cent of the total fuel oil reaching the Atlantic Seaboard was transported by tanker. Because of the transfer of many tankers to Britain earlier in the war, the submarine menace along the coast, and later, the diversion of many tankers to the transportation of gasoline across both the Atlantic and the Pacific to the armed forces, the shipping of fuel oil by tanker to points along the Atlantic Seaboard practically ceased. Additional tankers now under construction must be employed for the mentioned purposes without regard to domestic needs.

To take their place, over 70,000 tank cars, or about 70 per cent of the total available, were put into service transporting more than 800,000 bbl of oil daily to the East Coast. With the assistance of barges and tank trucks, this quantity was stepped up to about a million barrels daily. The haulage is long and it requires 280 tank cars to equal the capacity of the average tanker, such as was earlier available for coastwise deliveries. The new very large tankers now serving the armed forces have a capacity equivalent to more than 500 tank cars, but these do not enter into the present comparison. However, this has created a threatened shortage in certain other sections of the country, particularly the North Central States, which were formerly supplied by tank cars. Increase in the number of barges is limited by the restricted use of metal for propulsion machinery and the use of tank trucks involves expenditure of much needed rubber.

Additional tank cars are out of the question because of the steel involved, hence the problem devolves upon increasing the turn-over of existing cars through reduction in length of haulage and scheduling their use so that there will be a minimum of cars idle at terminals.

Although the early proposal of Secretary Ickes for a pipe line to the East was defeated on the score of the material and labor involved and the time required for completion, a shorter line from Longview, Texas, to Southern Illinois was authorized and is expected to be ready in December. This 24-in. line will have a capacity of 300,000 bbl daily. While some of this oil will be consumed in the Middle West, it is estimated that 100,000 to 150,000 bbl daily will be available for rail shipment to the East. This will cut down greatly the length of haulage for this portion of the requirements and release a considerable number of cars for supplying the other sections of the country which have heretofore been dependent on tank car delivery.

The Middle West consumes normally only about one-half the quantity of fuel oil and distillates burned in the Atlantic Seaboard States, and of the latter (with Florida excepted) about 85 per cent is utilized north of Washington, D.C.

A large proportion of the railway locomotives in the Southwest and Middle West burn oil and such consumption in the first six months of 1942 increased 28 per cent over the corresponding period last year.

Replenishment of Reserves Vital

There is no actual shortage of petroleum at the source; instead it is a matter of transportation and a shortage of reserves in the regions affected, particularly in the East. The concern of the Government is to prevent this shortage in reserves from developing into an actual deficit with its many dire consequences.

To cope with the situation three measures have been adopted, namely: (1) conversion to coal burning wherever possible; (2) a campaign of fuel conservation; and (3) fuel oil rationing.

Conversion to Coal

So far all conversions have been voluntary, although an order exists that would make such action mandatory were it to be invoked. To date industrial plants in the East have converted to the extent of about 25 per cent and the average for New England is slightly higher. This has been reflected in the greatly increased volume of stoker sales within the last few months. It is believed that at least 30 per cent of existing domestic and building oil-burning installations can be converted readily to coal, and perhaps more through greater expenditure on the part of the owner, although to date such conversions are estimated at only 5 to 6 per cent. However, more exact figures should be available as a result of a complete survey of oil-burning installations which the Government is planning to undertake shortly with a view to ascertaining definitely those that are susceptible to conversion.

The Government has cleared the way for domestic conversions by arranging for priorities on materials and the manufacture of lugs, shaker bars, grates and ashpit doors. The OPM has also made available 11,000 tons of materials for industrial stokers. Special emphasis is being placed on industrial plant conversions not only because of the large quantities of oil involved in individual cases but also because much less material is required per gallon of oil burned. Although every effort will be made to supply war production plants with necessary oil, this will not absolve those that can convert from doing so.

Fuel Conservation

With reference to fuel conservation, it is emphasized that this should apply to both oil and coal; also manufactured gas and electricity. Lower room temperatures during the heating season are urged and the elimination of waste wherever existent; this includes more efficient plant operation. It is predicted that by next year it may become necessary to conserve an additional 100 million barrels of oil, or about 25 per cent of the total consumption.

Response to the plea for summer storage of coal among utilities and industrial plants was generally satisfactory and coal production is at present just about able to keep pace with the demand. However, additional conversions, still greater war production and the winter peak will increase the demand, which increase may or may not be offset by coal now in storage. Estimates by the Office of Solid Fuels Coordinator for War place the 1943 requirements at 600,000 tons of bituminous coal and 60,000,000 tons of anthracite as compared with 560,000,000 and 58,000,000 tons, respectively, for 1942.

The Selective Service Draft and enlistments have made some inroads among the younger miners, and some degree of absenteeism has been reported. It should be remembered further that the miners are at present working on the basis of only a 35-hr week. According to a report of the National Coal Association, the bituminous coal mines, as of September 30, were producing 94.2 per cent of their total mine capacity. If this working week is not increased, it may be necessary to provide additional mining facilities in the form of opening up new mines or more machinery which will involve the use of strategic materials. In fact, believing that the nation's mines under present conditions may not be able to meet future coal requirements, Secretary Ickes recently called a conference representative of the interests concerned with a view toward assuring expanded operations, but to date nothing definite has resulted from this conference aimed at lengthening the miner's working week. These factors, considered in connection with the coal transportation burden on the railroads, emphasize the importance of coal conservation wherever possible.

It has been estimated that by conversion and conservation in the residential heating field alone 25 million tons of coal, 19 million barrels of oil and 21 billion cubic feet of gas could be saved annually. This would release for other necessary uses 153 million gross tons of freight for 3000 miles and 7700 tank cars. In the industrial power plant field, despite the large number of conversions already made, further large savings are possible through further conversions.

Fuel Oil Rationing

The ban on fuel oil deliveries for domestic consumption in seventeen eastern states which went into effect on August 3 was later lifted to permit tanks for household heating to be filled up to 275 gal, from September 16 to September 30, and in premises other than private dwellings, tanks could be filled up to 50 per cent of capacity.

Complete rationing of fuel oil with a coupon system for heating purposes and hot water went into effect on October 1 in the states of Connecticut, Delaware, Florida (east of the Apalachicola River), Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Rhode Island, South Carolina, South Dakota, Vermont, Virginia, West Virginia, Wisconsin and the District of Columbia.

It was decreed that oil for heating would be denied to apartment houses, commercial, industrial and institutional establishments which possess the facilities to convert their furnaces to coal burning. Furthermore, it was announced that in no case, whether it be a private home or a manufacturing plant, would any establishment be eligible for fuel oil rationing if a new oil burner or equipment for converting the furnace from other fuels to oil had been installed since June 1, 1942. The greatest unknown factor is the severity of the weather next winter, but in order to take cognizance of climatic conditions, the OPA has divided the restricted area into four zones and these will form a guide to adjustment of fuel oil rationing to climate.

Those burning fuel oil for heating in those states where rationing has been applied will have to get along, on the average, with about two-thirds of their normal fuel supply, unless they convert to coal.

Use of fuel oil for spraying and dust-proofing coal is now prohibited.

Effect of Gasoline Rationing

The extension of gasoline rationing to the remaining states, in addition to that existing in the East, as urged initially by the Baruch Report and later ordered by the WPB, was primarily aimed at the conservation of rubber, but it will also have a direct bearing on fuel oil supply. It is anticipated that such wide rationing may actually

result in a surplus of gasoline in certain sections. This can be controlled to some extent by refining processes which make it possible to turn out more fuel oil and less gasoline. More distillate products will also be required for the production of synthetic rubber.

Another possible means of utilizing excess gasoline with a corresponding saving in oil is in the enrichment of manufactured gas—a commodity that now consumes large quantities of oil. To this end experiments have been underway for some time and favorable results are reported.

Colloidal Fuel Proposed

Some will recall the work undertaken in this country during the last war in connection with colloidal fuel—a mixture of coal and oil—which it was believed might be adaptable to marine use. Results at the time did not come up to expectations and the experiments were dropped, although further research was subsequently carried on in England with more promising results. However, economic conditions at the time apparently did not justify its wide adoption. Lately, however, further investigations have been made along this line and are reported as encouraging.[1] Despite certain operating difficulties which it might entail, particularly as to slagging of heating surfaces, it is possible that this may offer one source of relief if the situation should become more acute.

In conclusion, it may be observed that the time has arrived for everyone concerned to take a realistic view of the situation. Those charged with the responsibility at Washington appear to know what they are talking about; they are doing their best to cooperate with consumers and the latter's best interests warrant a like response. The situation is almost certain to change from time to time and necessitate modifications in the measures for control, but from present indications one would indeed be optimistic to expect any marked easement in the near future. On the contrary, it is likely to be more stringent as the war progresses.

[1] At the recent Joint A.I.M.E.-A.S.M.E. Fuels Conference in St. Louis, Dr. W. C. Schroeder, of the U. S. Bureau of Mines, presented a paper on "Use of Mixtures of Oil and Coal in Boiler Furnaces."

St. Lawrence Power Shelved

The recent assertion by President Roosevelt that further efforts to force construction of the St. Lawrence Power Project would be held in abeyance for the duration of the war will be highly disappointing to the public power advocates within the Administration and in Congress. Although this particular development has long been one of the President's most ardent desires, he has wisely taken cognizance of the present materials and labor situation. Furthermore, the power situation now appears to be well in hand and St. Lawrence power could hardly become a factor for several years.

This does not mean, however, that the proposal is dead. On the contrary, as a post-war construction project it will undoubtedly be pressed with renewed vigor. None can foretell what the power situation will be with the cessation of hostilities and when that time arrives it would be logical to review the proposition, without bias, in the light of conditions then existent.

Facts and Figures

Nearly 45 per cent of the dry weight of wood is oxygen.

●

Spreader stokers have been employed for boiler capacities up to 200,000 lb of steam per hour.

●

In a modern high-pressure, high-temperature steam generating unit about 25 per cent of the heat in the fuel is absorbed by the superheater.

●

The effectiveness of turbulence in a pulverized-coal-fired furnace is indicated by the percentage of unburned carbon in the ash leaving the furnace.

●

Recovery of river anthracite on a commercial scale in Pennsylvania dates back to 1890. In the intervening years, the output has steadily increased until it now amounts to close to a million tons annually.

●

The exposure time with one million volts X-ray, such as is now being employed for examining welds in large boiler drums, is less than one one-hundredth of that necessary with the 400,000 volts formerly used for a $5^1/_4$-in. plate with equal focal distance.

●

While several 1800-rpm single-shaft turbine-generators up to 160,000 kw capacity are in service, units of this type now operating at 3600 rpm are 50,000 kw or less, although one of 75,000 kw is understood to be on order.

●

Electric energy produced for public use in August 1942 broke all previous records by totaling 16,031,777,000 kw-hr, an increase of 11.9 per cent over that of August 1941. The figures, released on September 28 by the Federal Power Commission, show that for the twelve months ending August 31, 1942, the total production was 14 per cent greater than during the twelve months ending August 31, 1941.

●

Despite the fact that the application of pulverized coal to steam generation, on a commercial scale, dates back only about twenty years, some early experimenters predicted many of the things that later came to pass. From 1870 to 1875, T. R. Crampton carried on extensive work in England, involving the burning of some 2000 tons of coal, and regularly used pulverized coal in a heating furnace at the Woolwich gun factory. Here the coal was ground in a flour mill to pass through a 30-mesh screen. In a paper before the Iron & Steel Institute he advocated water-cooled furnace walls and tapping the slag when applied to boilers, and related experiments with a marine boiler. He further advocated finer grinding when applied to low volatile coals.

Inspection and Maintenance of Superheaters

By F. I. EPLEY

Combustion Engineering Co.

BY THE proper proportioning of superheating surface for the intended service and by providing adequate steam velocities to afford ample cooling of the elements, designers are able to take care of normal operation. Moreover, superheaters are usually constructed with a margin of safety such as will assure adequate service over long periods. But it is well nigh impossible, and certainly uneconomical, to design so as to meet all conceivable unfavorable conditions that may arise. Hence, in times such as the present when steam generating units are being called upon for long sustained operation at high capacity, often with inferior fuels, it behooves operators to note carefully all indications of erratic behavior. By so doing and taking corrective measures in time, unscheduled or emergency outages may be avoided. This applies to the small plant as well as to the large high-pressure, high-temperature station.

Because of the nature of the service which superheaters are called upon to perform, it is often necessary to employ materials that are at present in the "hard-to-get" category. This emphasizes the necessity of protecting and conserving superheating equipment through close attention to performance and the maintenance of regular and adequate inspection.

Aside from operation under load, there are periods when special attention should be given to protecting the superheater elements from overheating. One of these is the starting-up period when heat is being given up by the products of combustion but steam is not being supplied to the prime mover. Drains or vent valves in the superheated-steam outlet header provide a means for maintaining a safe tube temperature at such times. With these valves open a sufficient amount of steam is permitted to pass through the elements to keep the metal temperature within safe limits. While this steam is in many cases blown to the atmosphere, in some installations its heat is conserved by passing it to a low-pressure header supplying steam for process or for heating. Obviously, these valves are closed as soon as the boiler is cut in on the line.

In shutting down a boiler, practice varies as to the opening of the superheater drain valves for a period after the normal steam flow has ceased. However, where the furnace contains a large amount of refractory surface or the unit is stoker fired, considerable time may be required for the furnace to cool down to a point where the superheater elements will not be susceptible to overheating.

Also, during banking periods the superheater header drain valves should be opened enough to provide protective flow of steam through the elements until the temperature of the gases has been sufficiently reduced.

Most warpage of superheater elements and numerous failures have been traced to a disregard of precautions during such periods.

While it is impracticable and uneconomical (except in isolated cases) to provide full safety-valve relieving capacity on the superheater outlet header, those that are installed are set a few pounds below that of the lowest set boiler-drum safety valve in order to blow and maintain circulation of steam through the superheater header should there be a sudden and unanticipated drop in steam demand that cannot be immediately handled by a reduction in firing rate.

External Deposits

Cleanliness of both the external and internal surfaces of a superheater is most important. External fouling may result from continuous heavy load, long sustained peaks or poor coal, or perhaps a combination of these factors. While all ash or slag accumulations interfere with the heat transfer and thereby affect the superheat, the deposits may be so distributed as to cause laning of the gas and result in localized overheating of the elements. This condition is especially undesirable in high-temperature installations where a high-average total-steam temperature must be maintained. If one side or section of the superheater becomes thus partially closed the steam temperature from that section is reduced, and in order to maintain the required average steam temperature, the remaining sections must operate at higher temperatures for both steam and metal. Another result is greater draft loss through the superheater. Thermocouples on the superheater elements and the outlet should reveal such a condition in time to take steps that will avoid trouble.

Dust, ash and porous slag deposits can be usually removed by soot blowers, but where the slag is plastic in character hand lancing becomes necessary. For this purpose, steam or air is employed, although the latter is preferable.

Internal Deposits

Internal cleanliness of superheater elements is of prime importance. Superheater tubes, like boiler tubes, must be clean internally in order to permit the necessary heat transfer, avoid overheating and assure long life. Such deposits, if extensive, will also increase the pressure drop across the superheater. Factors that contribute to deposits on the internal surfaces are overloads, fluctuating loads, high water level, foaming and high concentrations in the boiler water. Hence it is essential that there be correct feedwater treatment and proper control of both steam quality and carryover.

Fortunately, most of these conditions can be checked periodically and corrective measures applied without taking the boiler out of service. For example, by periodic checks on the steam pressure drop across the superheater, at some particular rating, the presence of accumulations of deposits can be readily detected and the cause of excessive carryover investigated.

If the internal deposits are, soluble, and they usually are, it is practicable to backwash the superheater elements by admitting water through the superheater outlet header when the unit is down. Generally, water at a temperature between 120 and 150 F will best serve the purpose.

Inspection

Superheaters deserve the same careful and periodic inspection as do other parts of a steam generating unit, and they work under more exacting conditions than most

(Continued on page 54)

Save Material on Piping Designs

By H. F. BEHRENS

The Commonwealth & Southern Corp., Jackson, Mich.

Because of the present critical materials situation, it becomes necessary in most cases to provide substitutions for those ordinarily employed in piping for high-pressure high-temperature service. This involves much greater weights of steel and runs counter to conservation which is now all-important. The author offers suggestions for piping arrangements aimed at reducing as much as possible the weight of material required.

NEVER before has this country been forced to conserve materials of any kind but now we find that almost everything is on the critical list. It is common for engineers to be forced to find a substitute for some restricted metal or alloy and it is not uncommon to be forced to find a substitute for the substitute. In an effort to find a metal that can be used for a given job, the engineer must forget all about the cost. He must even forget about the total weight of the material required. The weight of the substitute, like the cost, is usually more than the original. With so many of our needs on the critical list the engineer must often work against the material conservation program rather than work with it. That is, he is forced to use low-strength metal with its resulting increase in weight in place of a high-strength metal or alloy of low total weight. This is because some low-grade alloys, such as are used in piping, have been restricted as piping material. A good example of this is carbon-molybdenum pipe used commonly for steam temperatures around 900 F. It is practically impossible to get carbon-moly pipe at present, but without the use of the one-half per cent of molybdenum, twice the total weight of steel is required.

Another problem with which the piping designer is confronted is the finding of a substitute for seamless steel pipe. This can only be solved by increasing the pipe wall thickness and using welded pipe. In small pipe sizes the increase in wall thickness will often result in an increase in the pipe size because the inside diameter has been reduced too far. Lap-welded and butt-welded pipe is not recommended for services over 750 F, but in spite of this, seamless steel pipe like carbon-moly pipe can be purchased only on a very high priority rating.

This waste of steel through improper use is not only true of piping, but is true in countless cases from hairpins up. In the case of piping, the engineer can and should so design his work to do the job with the smallest amount of metal possible. He should now look at his problem with the thought of saving metal first and dollars second. In the accompanying tabulation the writer shows how piping designs can be improved, the weight greatly reduced and the cost lowered. The comparison is between various methods of making a 90-deg branch or tee connection and between various ways of making a 90-deg turn or elbow connection.

In the tee or branch connections welding is regarded as superior to flanges and in changing the direction of a pipe run bends are superior, with the welding fitting second. The elimination of flanges and gaskets will give a leak-proof joint that will withstand a higher hydrostatic pressure without failure. Welded piping will also take changes in temperature and sudden shock without leaking. In addition to this, the elimination of the flanges will improve the piping layout and provide more space for insulation. It will be noted that the cost of the insulation is also greatly reduced as a result of the streamline bending or welding. The reduced cost of the supports has not been taken into account because this will vary with different types of work.

Six-inch pipe size has been selected for the comparison because it is about the average size for most installations of power and industrial piping. The saving in material is much greater as the pipe size increases. Let us compare the weights of a 12-in. 900-lb pressure flanged-tee section against a welded 90-deg branch of the same dimensions as shown in the tabulation.

12-In. Series 90 Flanged-Tee Section

5 ft 0 in.—0.843-in. wall pipe	= 540 lb
Series 90 flanged tee	= 1742 lb
3 Van Stone flanges	= 1113 lb
60—1$^1/_8$-in. studs (2 nuts)	= 382 lb
Total	= 3777 lb

12-In. Reinforced Welded Branch Section

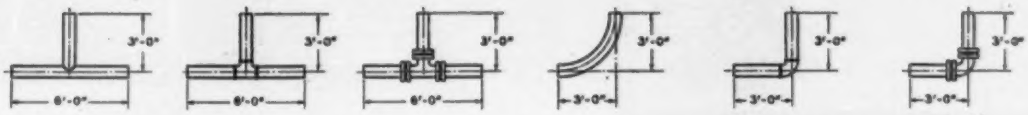
9 ft 0 in.—0.843-in. wall pipe	= 972 lb
12-in. × 12-in. welding saddle	= 125 lb
Total	= 1097 lb

This shows a saving of 2680 lb of steel in one branch connection over a tee.

It will be noted that in all of the comparisons for 750 F service, Van Stone flanges have been used in place of other types of flanges that are available. Van Stone and weldneck flanges are preferred over slip-on or screwed flanges because screwed flanges should be used only on low-pressure low-temperature work and the slip-on flanges are limited to 300 lb pressure by the A.S.M.E. Boiler Code and the A.S.A. Piping Code. Weldneck flanges cost more than Van Stone due to the butt weld required and the total weight is about the same. The weight of the material for the Van Stone lap is included in the weight of pipe but the cost of the extra pipe is in the cost of the Van Stone flange and lap.

The prices used on pipe, flanges, fittings and welding are the pipe fabricator's net schedule, and the insulation prices are those prevailing in the Detroit area. The cost of field work such as insulation and field welding will vary with the rate paid in the various localities. The weights given are catalog weights and are fairly accurate. It is assumed that the sections chosen for the comparison are part of a system and not a piece to be welded into place after fabrication.

COMPARISON OF COST AND WEIGHT
6-In. Fabricated Pipe



	Cost	Weight, Lb	Cost	Weight, Lb	Cost	Weight, Lb	Cost	Weight, Lb	Cost	Weight, Lb	Cost	Weight, Lb
150 Lb, 750 F Service												
Pipe—standard L. W.	$7.56	171	$6.30	142	$6.81	147	$3.90	90	$3.78	86	$4.54	90
Flanges—V. S.	....	...	....	...	36.72	57	...	...	...	...	24.48	38
Fittings	....	...	17.01	29	39.56	110	...	...	9.60	22	28.38	100
Stud bolts	....	...	....	...	5.43	25	...	...	...	...	3.62	17
Welding	18.27	...	30.45	...	....	...	...	...	20.30	...	....	...
Bolting labor	....	...	....	...	2.64	...	...	...	...	...	1.76	...
Bending labor	....	...	....	...	....	...	23.61	...	...	...	....	...
Gaskets	....	...	....	...	0.54	...	...	...	...	...	0.36	...
Insulation	24.56	...	24.56	...	35.74	...	16.05	...	16.16	...	27.03	...
Total	50.39	171	78.32	171	127.44	339	43.65	90	49.84	108	90.17	245
300 Lb, 750 F Service												
Pipe—standard L. W.	$7.56	171	$6.30	142	$6.81	138	$3.99	90	$3.78	86	$4.46	90
Flanges—V. S.	....	...	....	...	42.66	117	...	...	...	...	28.44	78
Fittings	....	...	17.01	29	51.52	182	...	...	9.60	22	36.96	139
Stud bolts	....	...	....	...	9.12	40	...	...	...	...	6.08	27
Welding	18.27	...	30.45	...	....	...	...	...	20.30	...	....	...
Bolting labor	....	...	....	...	3.96	...	...	...	...	...	2.64	...
Bending labor	....	...	....	...	....	...	23.61	...	...	...	....	...
Gaskets	....	...	....	...	0.78	...	...	...	...	...	0.52	...
Insulation	24.56	...	24.56	...	38.74	...	16.05	...	16.16	...	29.61	...
Total	50.39	171	78.32	171	153.59	477	43.65	90	49.84	108	108.71	334
400 Lb, 750 F Service												
Pipe—standard seamless	$8.76	171	$7.30	142	$6.33	138	$4.62	90	$4.38	86	$4.22	95
Flanges—V. S.	....	...	....	...	51.81	126	...	...	...	...	34.54	84
Fittings	....	...	17.01	29	76.16	210	...	...	9.60	22	53.76	170
Stud bolts	....	...	....	...	12.00	50	...	...	...	...	8.00	33
Welding	36.53	17	30.45	...	....	...	...	...	20.30	...	....	...
Bolting labor	....	...	....	...	5.40	...	...	...	...	...	3.60	...
Bending labor	....	...	....	...	....	...	23.61	...	...	...	....	...
Gaskets	....	...	....	...	0.78	...	...	...	...	...	0.52	...
Insulation	24.56	...	24.56	...	39.63	...	16.05	...	16.16	...	30.76	...
Total	69.85	188	79.32	171	192.11	524	44.28	90	50.44	108	135.40	382
600 Lb, 750 F Service												
Pipe—E. H. seamless	$14.38	257	$11.99	214	$9.99	200	$7.59	136	$7.19	129	$6.66	133
Flanges—V. S.	....	...	....	...	77.40	234	...	...	...	...	51.60	156
Fittings	....	...	21.26	43	101.92	332	...	...	12.00	33	68.32	216
Stud bolts	....	...	....	...	18.15	72	...	...	...	...	12.10	48
Welding	53.91	17	40.26	...	....	...	...	...	26.84	...	....	...
Bolting labor	....	...	....	...	7.02	...	...	...	...	...	4.68	...
Bending labor	....	...	....	...	....	...	23.61	...	...	...	....	...
Gaskets	....	...	....	...	0.90	...	...	...	...	...	0.60	...
Insulation	24.56	...	24.56	...	45.98	...	16.05	...	16.16	...	35.70	...
Total	92.85	274	98.07	257	261.36	838	47.25	136	62.19	162	179.66	553
900 Lb, 750 F Service												
Pipe—seamless—0.562" thk.	$18.26	327	$15.22	273	$12.17	246	$9.64	173	$9.13	164	$8.12	170
Flanges—V. S.	....	...	....	...	142.14	315	...	...	...	...	94.96	210
Fittings	....	...	58.25	61	187.55	452	...	...	28.98	43	121.00	293
Stud bolts	....	...	....	...	26.79	144	...	...	...	...	17.86	96
Welding	80.04	17	60.03	...	....	...	...	...	40.02	...	....	...
Bolting labor	....	...	....	...	8.91	...	...	...	...	...	5.94	...
Bending labor	....	...	....	...	....	...	23.61	...	...	...	....	...
Gaskets	....	...	....	...	1.29	...	...	...	...	...	0.86	...
Insulation	24.56	...	24.56	...	50.32	...	16.05	...	16.16	...	38.88	...
Total	122.86	344	158.06	334	429.17	1157	49.30	173	94.29	207	287.62	760
125 Lb, 450 F Service												
Pipe—standard L. W.	....	...	....	...	$5.88	133	...	...	...	...	$3.92	78
Flanges—standard C. I. Scrd.	....	...	....	...	4.53	57	...	...	...	...	3.02	38
Fittings	....	...	....	...	10.31	110	...	...	...	...	7.00	100
Stud bolts	....	...	....	...	2.04	18	...	...	...	...	1.30	12
Making on & R. F. flanges	....	...	....	...	13.38	...	...	...	...	...	8.92	...
Bolting labor	....	...	....	...	2.64	...	...	...	...	...	1.76	...
Gaskets	....	...	....	...	0.54	...	...	...	...	...	0.36	...
Insulation	....	...	....	...	28.01	...	...	...	...	...	22.93	...
Total	....	...	....	...	67.33	318	...	...	...	...	49.36	228
250 Lb, 450 F Service												
Pipe—standard L. W.	....	...	....	...	$5.88	130	...	...	...	...	$3.85	78
Flanges—B. H. C. I. Scrd.	....	...	....	...	7.32	117	...	...	...	...	4.88	78
Fittings	....	...	....	...	15.53	182	...	...	...	...	10.67	139
Stud bolts	....	...	....	...	3.33	31	...	...	...	...	2.22	20
Making on & R. F. flanges	....	...	....	...	13.38	...	...	...	...	...	8.92	...
Bolting labor	....	...	....	...	3.96	...	...	...	...	...	2.64	...
Gaskets	....	...	....	...	0.78	...	...	...	...	...	0.52	...
Insulation	....	...	....	...	30.41	...	...	...	...	...	25.14	...
Total	....	...	....	...	80.59	460	...	...	...	...	58.84	315

Some Ways to Avoid HIGH STOKER MAINTENANCE

In the following excerpts from a paper before the Joint A.S.M.E.-A.I.M.E. Fuels Meeting at St. Louis, Sept. 30–Oct. 1, the author deals specifically with the prevention of metal burning by maintaining an adequate flow of air to remove the heat as fast as it is delivered and by maintaining a porous insulating layer on the fire side of the stoker. Numerous cases are cited from practice of troubles encountered and the remedial measures adopted and reference is made to the opinions expressed by other discussers of this subject.

By A. R. MUMFORD

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PROBABLY the greatest single item associated with high maintenance is the burning of stoker metal. Others, such as wear, appear from time to time, but this is not usually abnormal in the well-designed stoker. The burning or overheating of stoker metal continues until the specific cause or causes have been found and eliminated. During the present emergency the difficulty of securing replacement parts is sufficient incentive for operators to eliminate all causes which have been shown to contribute to stoker metal burning.

In this paper only two problems associated with the burning of stoker metal will be considered, namely, maintenance of an adequate flow of air to remove the heat from the part as fast as it is delivered and maintenance of a porous insulating layer on the fire side to keep the flow of heat to the stoker parts down to a value which can be picked up by the combustion air. It is apparent that the insulating layer must be porous so that it does not retard the flow of cooling air sufficiently to permit the temperature of the stoker parts to rise to the burning point.

Most types of stokers move the fuel progressively from the point at which it enters the furnace as green fuel to that at which the residue is discharged. In chain-grate or traveling-grate stokers the progressive motion of the fuel is essentially in one plane without vertical agitation. In the underfeed type, both single- and multiple-retort, the progressive motion is complicated by upward and sidewise motions necessarily superimposed on the principal longitudinal motion.

Chain-Grate Stokers

These stokers are ideally suited to the burning of high-ash free-burning coals. When a coking coal is used the fact that the fuel is moved essentially in one plane makes it impossible to offset mechanically any tendency to mat over. Such matting will reduce or cut off the air supply through the matted area and allow the stoker metal to heat, perhaps excessively; and will also allow partly burned fuel to be discharged into the ashpit. Where low-ash coals are burned the protection to the stoker metal at the rear may be insufficient and, if such parts as the rear shaft are not hollow and water-cooled, overheating and warping may result.

In the natural-draft type the resistance of the fuel bed must be kept within the limitations imposed by the draft source through selection of the proper size analysis of the fuel. Obviously, the forced-draft type will permit the use of a size analysis considerably higher in fines. Any condition of high furnace draft imposed by the resistance of the fuel bed will result in increased setting leakage and stack losses. In any consideration of fuel sizing the effect of segregation cannot be overlooked. Fuel, which in the course of handling becomes segregated with respect to size as it reaches the stoker grates, produces a fuel bed of uniform depth but widely varying resistance. The areas on which the coarser fuel is segregated will receive more than their proportion of the air supply, burn through and expose that area to excessive radiant heat while still in the hotter zone of the furnace. Correspondingly, those areas composed of finer coal and offering relatively high resistance to the flow of air will receive less of the air supply and be only incompletely burned by the time the ashpit is reached. The writer has seen chain-grate surfaces which had acquired a permanent wave, attributed by the operators to segregation of fuel sizes because of the system used for delivering the fuel to the stoker hoppers.

There is general agreement that the addition of moisture in some cases, to the extent of about 10 per cent by weight, improves the burning quality of the fuel. The moisture may be added in the form of water if 24 hr or more are available while the coal is in storage, or in the form of moist exhaust steam introduced into the stoker hopper if insufficient storage time is available.

The tendency of ash to form side-wall clinker, which may grow and form a dam, clearing the fuel from a portion of the grate surface as the grate travels to the rear, should be watched for and guarded against by providing means and access for its removal. Of course, if the owner is in a position to secure the necessary priorities, design changes can be made; but for the plant which finds such procedures difficult or impossible, watchfulness and a slice bar will prevent the stoker metal from being overheated and burned.

Some cases of metal burning have been traced to the practice of shutting off the air supply and stopping the stoker when the demand for steam decreases. Such a practice stops the cooling of the stoker metal by the air

and permits overheating and burning. When the necessity for some air flow is kept in mind, minimum rates of combustion can be set at about 15 lb per sq ft per hr, below which the stoker should be stopped and burned down. The exact practice must be determined by the nature of the plant load and equipment but it is emphasized that the air should not be shut off completely when the load is decreasing.

The introduction of air over the fire has long received attention and often been discussed. Its purpose is to provide oxygen for the combustion of the unburned gases rising from the fuel bed and to mix the two.

Experience indicates that all air should pass through the fuel bed in order to insure as nearly as possible the complete burning out of the combustible matter in the fuel, and the excess oxygen in the leaner portions of the gas should be made available to the richer portions by mixing arches. This can be done at one broad point of the rating curve but at other lower points the mixing action of the arches becomes less effective because of lower velocities, and can economically be supplemented by overfire air jets. Small jets of steam can be used to study the effectiveness of each available location for air jets, these jets to be replaced by air after the best location is determined. Higher pressures than are available from stoker windboxes are required to form jets capable of penetrating the gas stream.

Traveling-Grate Stokers

The traveling-grate stoker differs in structural design from the chain-grate stokers but functionally it is the same. The area of grate surface open to the passage of air is small and at high combustion rates the air actually jets through the fuel bed. As a practical matter the burning of steam sizes of anthracite on stokers is limited to the traveling-grate type, but this type of stoker is not limited to anthracite. Most of the causes for high maintenance applicable to the chain-grate stokers are also applicable to the traveling-grate stoker.

The writer made an extensive investigation of combustion of anthracite on this type of stoker in 1923, a report of which was published in the March 1924 issue of *Mechanical Engineering*. On these tests the ineffectiveness of overfire air introduced under stoker windbox pressure was demonstrated as was the effectiveness of the mixing action of steam jets under 150 psi. Although the small plant may be unable to secure the necessary priorities for refractory or water-cooled arches some gains may be made by experimentally located air or steam jets to simulate mixing arches or to increase the effectiveness of existing arches.

Unpublished results of a series of investigations of the influence of size analysis on efficiency and capacity clearly demonstrated that the maximum capacity obtainable from a given piece of equipment decreased almost in proportion to the undersize content of the fuel. The efficiency obtainable at maximum capacity decreased with increase in undersize content of the fuel somewhat in proportion to the carryover of cinders which increased with the amount of undersize. This information is here introduced so that those who may be compelled to change to anthracite or similar non-coking coals, having increased percentage of undersize, will be made aware that the same capacity and efficiency cannot be obtained as was obtained with the coarser fuel.

With low-volatile fuels, such as anthracite, ignition is dependent upon the rate at which heat is received by the surface of the fuel as it enters the furnace. This was discussed by Walter H. Wood in an article entitled "Grate Temperatures, a Measure of Ignition Penetration" appearing in COMBUSTION for February 1942. The late Percy Nicholls, of the U. S. Bureau of Mines, was engaged in an extensive study of the effect of fuel sizing and air flow on the rate of temperature penetration of a fuel bed at the time of his death. Experience determined that anthracite must be allowed an appreciably long time for ignition penetration before rapid combustion can be forced. In furnaces without mixing arches this requires an initial quiescent area with the bed becoming more active as it approaches the ashpit. In furnaces with mixing arches or with only one effective rear arch it is customary to force rapid combustion in the zone just in front of the nose of the rear arch. This forcing can be enough to blow solid incandescent particles forward to aid in the initial ignition of the green fuel. This is possible without serious danger of exposing the rear section of the grate to overheating because of the shielding action of the rear mixing arch. This shielding action cannot be simulated by air jets.

Heat From Siftings May Injure Windboxes

Some siftings are unavoidable and if they are allowed to accumulate because of carelessness or oversight they may ignite and burn in the air chambers. The heat generated has been sufficient in some cases to distort the windboxes, destroy control of the air or actually burn the metal. It has been found by the New York Steam Corporation that an inch of grout on the bottom of the air chambers will reduce the damage materially.

Where screenings are burned or culm banks serve as a source of fuel, the rate of ignition may be slowed down to the point that at low or banked ratings in cool furnaces ignition is difficult to maintain. In such cases the rate at which air must be supplied to the front section to secure the maximum rate of heat penetration for a given grate speed must be determined in the field and adhered to thereafter. Mr. Nicholls' data, when published, will serve as an excellent guide in such cases. Rapid combustion should not be attempted until that point in the travel of the grate is reached at which nearly the whole depth of the bed has reached ignition temperature.

The mixing arches over traveling-grate stokers are designed to bring the rich and lean strata of gases into intimate contact and thus to improve the uniformity of the gas mixture. In accomplishing this result combustion is intensified, average excess air is decreased and furnace temperatures are raised. The higher furnace temperatures increase the rate of ignition which is distinctly advantageous with fuels of the character of anthracite, but such higher temperatures also tend to cause those ash particles which settle out in the eddies above the arches to sinter or fuse into so-called clinkers. If these lumps of ash are allowed to accumulate to a size too big to pass under the rear mixing arch or too big to pass between the end of the stoker and the rear wall, it is obvious that something will have to give when the lump reaches the restriction. If shear pins have been replaced by heavier ones than the design calls for, as has happened, the pins will not shear but the grate bars may be bent or broken and result in a fairly serious outage. Obviously,

if a fuel is tried which exhibits the tendency to form such clinker, the clinker should not be allowed to grow to a dangerous size. Such accumulations can be removed with bars or blown off the refractory through properly located access doors before they reach a dangerous size.

Multiple-Retort Stoker

In their paper "Ten Years of Stoker Development at Hudson Avenue" (A.S.M.E. *Transactions*, Feb. 1935) J. M. Driscoll and W. H. Sperr described in detail an extensive series of mechanical changes made in multiple-retort underfeed stokers in their attempts to overcome certain fuel bed difficulties. They found that increasing the air entry area into the upper section of the stoker seemed to have no appreciable beneficial effect on the obtaining of high ratings. Raising the retort bottom along its entire length to shallow the retort and obtain greater agitation and looseness of the fuel bed failed to eliminate clinker on the tuyère row at the upper end. In order to get still more upward motion of coal out of the retorts at the upper end, the upper secondary rams were made to move upward toward the tuyères as well as down the retort and lift coal on its top surface into the fuel bed. They found that this change eliminated clinker immediately above the special upper secondary ram but in the section of fuel bed immediately following, tuyère clinker was experienced. Quoting from their paper,

> "The final change made was to install telescoping rams, which combined the effective motion down the retort of the straight-line design, and a uniform upward motion of green fuel toward the tuyères. On test this design was capable of maintaining a uniform fuel bed over its entire length at coal-burning rates up to approximately 53 lb per sq ft per hr for 24-hr periods. At this burning rate, however, the fuel bed tended to become sensitive and was likely to blow off in any section.
>
> "It is known that this capacity limitation does not apply to extremely short stokers probably because of the better opportunity for operating supervision and the quicker response of the fuel bed to control measures. The exact length at which this capacity limitation becomes effective is not known from experience at Hudson Avenue; it is probably considerably shorter than the approximately 13-ft long underfeed section of the original unit."

These quotations from Driscoll and Sperr's paper have been made to emphasize that what are undoubtedly logical mechanical changes did not compensate for the less desirable fuel properties as the rating was forced higher and higher.

In one underfeed-stoker-fired plant the grate bars on the overfeed section burned out in comparatively short periods, and the furnace smoked during the periods in which the load changed. After careful study and examination the production of smoke was attributed to three factors: First, the automatic control responded too quickly for the fires, either reducing the air flow faster than the stoker speed was reduced on decreasing load or increasing the stoker speed faster than the air supply on increasing load. Either condition resulted in a decrease in excess air and smoke on load changes. Obviously, the vendor of the automatic control should be completely informed as to the characteristics of all auxiliaries on the apparatus to be controlled. Second, the stoker cam adjustments had been allowed to wear to the point at which they no longer held the proper index and the fuel bed would change causing increased combustion rates on active parts and clinker on inactive parts. Lubrication had been rare or entirely absent. Third, the operators, who had been accustomed to another stoker, tried to hold the fuel bed conditions the same as on the other stoker, resulting in fires that were too heavy for proper operation.

The burning of grate bars on the overfeed section could be observed from the windbox through which these bars could be seen to glow dull red. The fuel used in this instance contained 5 to 6 per cent ash. With such a fuel it should be obvious that one of the factors upon which dependence is placed for the protection of stoker iron is somewhat low and to offset this lessened protection greater attention to the proper distribution of cooling air is required.

If clinker or uneven fuel bed thickness is allowed to affect adversely the air distribution, stoker metal will burn. In this instance the operators thickened the fuel bed at the clinker pit by not grinding it down uniformly or regularly. The pit accumulation reacted physically on the remainder of the fuel bed, prevented effective operation of the mechanical parts and increased the rate of clinker formation on the overfeed section. The operators also had the habit of closing all dampers to the overfeed section during periods of light load. Occasional failure of the automatic control on the stack damper caused it to shut and subject the fuel bed and stoker to a "soaking" heat. It was also discovered that each set of operators had different ideas about the length of pusher travel and operated the stokers accordingly. Maintenance decreased to normal and combustion efficiency improved when the obvious corrections were made.

A. S. Griswold and H. E. Macomber, in their paper on "The Distribution of Air to Underfeed Stokers," (A.S.M.E. *Transactions*, January 1936), say:

> "The limit of dependable coal-burning capacity, either with or without an air-control system, is determined by the ability to keep the fuel bed in a workable condition. With the high air velocities occurring when operating at high combustion rates, there is a tendency to lift small particles of coke from the fuel bed and deposit them in drifts in other parts of the fire. This action, if permitted to become sufficiently aggravated, eventually causes whole sections of the fuel bed to become thin, while heavy drifts, through which no air will pass, make their appearance in other sections. The effect is cumulative, and it is soon necessary to reduce load until the fuel bed can be worked into proper shape and condition. Without an air-control system, the fuel-burning rate must be kept sufficiently low to prevent this drifting from becoming serious.
>
> "The most important item of expense in the operation of a boiler plant after fuel and operating labor is stoker maintenance. Often more can be saved by efforts directed toward minimizing it than in attaining higher combustion efficiency. It is an expense subject to many variables for a particular installation. Among these are the coal-burning rates, the accumulated total of hours in service, the temperature of the air supply, the grade of coal as well as the skill and attention of the operator. Some of these factors are obviously determined by plant design and others are to an extent controllable in operation."

In another case side-wall tuyères burned. The conditions at this plant indicated the advisability of knowing at least the ash content of the fuel being fed to the fires. It was noted that the coal-handling equipment caused a segregation of sizes so that the coarser fuel was fed at the sides of the stoker and the side-wall tuyères deteriorated rapidly. Other difficulties were the low ash content of the fuel and operation of a fairly high-capacity stoker at ratings little higher than a banked condition for long periods.

It was ascertained that the segregation of the larger fuel sizes at the sides of the furnace permitted higher rates of combustion to exist in those areas, and the jet discharge or molten fly ash which gradually built up, shut off air through the top portion of the tuyères and

transmitted heat at high temperature by conduction to the bars. Incidentally, the side-wall tuyères used at the time were supplied by a local foundry and were made larger than those of the stoker manufacturer. The top locking tuyères, as observed from underneath the stoker, were heated to pale yellow. When advised to procure a coal of higher ash content, the operators finally told the service engineers that such a coal was on the fire; but it was noted that actually the grates were not dumped as often as previously although the load was twice as great.

At very low ratings it was noted that the side-wall tuyères were red hot and that opening the dampers under these tuyères made no improvement. Apparently the stoker, purchased for a maximum capacity which was not approached in regular plant operation, was too large for the low loads existing for fairly long periods. The minimum stoker speed was too slow for the rate of ignition along the front wall with this low-ash coal, allowing the fire to burn under the throat castings. A lower grade higher-ash coal would necessitate faster operation of the stoker at low ratings. When the stoker was stopped for long periods, as was sometimes required, the fire burned back into the hopper.

It was discovered in another instance that the power supply to the forced-draft fan motor had been connected so that the fan actually drew air down from the fire through the stoker. Of course, the duration of this difficulty was short but such things do happen.

The effect of heavy loads and hot furnaces was discussed by J. E. Tobey in a paper on "Underfeed Stokers and Coal Selection" (A.S.M.E. *Transactions*, 1938). His description of what happens with an unsatisfactory fuel is well worth recalling; he said in part:

"Unsatisfactory coals almost always manifested the same unmistakable signs of distress: (*a*) caked and dense upper fuel-bed section, which is practically non-porous and of dull appearance; (*b*) lower section of fuel bed too porous and containing holes, with large clinkers above tuyère rows, fuel in the form of large blocks of coke, great excess of air, high gas velocities, and white-hot appearance; and (*c*) tube and wall slag deposited by high velocity jets issuing from the fuel bed, molten slag running down the bridge wall and freezing on dump plates, and slag formations at bottom of side and front walls which disturb adjacent portions of the fuel bed and cause hot spots, clinker trouble, and back smoking through the stoker hopper .... In extreme cases secondary combustion occurs in the upper furnace and first pass of the boiler which is caused by delayed mixing of the gases on account of poor air distribution."

In his closure Mr. Tobey stated that in instances where so-called non-coking coals of lower ash-softening temperatures cause matting or surface hardening of the fuel bed, observations indicate that the cause very likely is due to the softening of the ash which results in a plate-like clinker, or a cementation action between molten ash and the coke particles either of which would cause the fuel bed to become impervious to air flow. The end result of this condition, he pointed out, bears a similarity to that of coking coals having a high ash-softening temperature, a high tar yield and a long plasticity range, in that both types of coals cause restricted air flow through the fuel bed and result in non-uniform burning over the grate area, hot spots and objectionable clinker trouble. In other words, the crux of these troubles is fuel bed porosity.

A. W. Thorson, in a discussion of Mr. Tobey's paper (A.S.M.E. *Transactions*, 1938, p. 368), said:

"At ... a station, burning a strongly caking coal on stokers with adequate agitation, segregation occurs in certain bunkers because of limitations imposed by the coal-handling machinery. It was difficult, even with zoned-air control, to keep as uniform a fuel bed as desired. Although this in itself is not a serious operating difficulty, it was observed that stoker iron loss was concentrated at the sections receiving the coarser coal. As an experiment the crusher was adjusted to reduce the coal size from $1^1/_2 \times 0$ in. to $^3/_4 \times 0$ in., with the result that the fuel beds appear uniform and stoker iron loss is slightly reduced."

Single-Retort Underfeed Stoker

The single-retort underfeed stoker may be considered as one unit of a multiple-retort stoker. Certain differences are obvious but the principal one is that moving grates take the place of tuyères at the side of the retort and longitudinal motion of the fuel is translated to lateral motion with the ash discharge at the sides rather than at the end. Because of this change in direction of flow, emphasis is placed on the proper motion of the parts to provide correct air distribution and progressive feeding and burning. In addition to the motion of the grate bars for uniform lateral distribution, the pusher blocks in the retort must be adjusted for proper longitudinal distribution. The required motion of the parts varies with the sizing of the coal and the setting for a fuel high in undersize will differ materially from that for a coarse fuel.

In any mechanism, on the surface of which rests a granular solid material, operating with relative motion between the parts, some sifting of the finer material between the parts will take place particularly where air spaces are also provided. The small windbox of a single-retort stoker is not designed for storage of fines and when it is realized that one plant failed to remove siftings over a six-month period, it can be readily understood that uniform air distribution could not have existed even though it may be surprising that the siftings were so few that the stoker could still operate. At this same plant the fuel was a medium low-ash coal and the importance of air distribution for cooling stoker iron was relatively greater than it would have been with a moderately high ash coal. Here, also, the operator so far forgot himself as to neglect to raise the dump plates after the ash had been dumped. The stream of partly burned fuel which tried to complete its combustion in the ashpit was successful in burning stoker iron.

At another plant the automatic control had been set to maintain a balanced draft in the furnace when a definitely negative pressure of about 0.15 in. was desired. The fine coal became plastic at the surface and matted and grate bars burned through. When the furnace draft was set for the proper value and the automatic control adjusted to maintain it, the high maintenance became reasonable maintenance.

In another case it was found that attempts were being made to burn a coal containing about 2 per cent ash whereas the specified coal was one containing about 7 per cent ash. Grates burned because of the absence of any protective layer of ash between the metal and the hot coal. The cooling power of the air alone was insufficient for protection. Satisfactory conditions were restored by a higher ash content obtained by blending with fuel from a different source.

Where the fuel ash is medium low, distribution of coal and air must be good to compensate for the lesser quantity of non-combustible available for protection of the grates. In stokers of the underfeed and moving-

grate type fresh fuel is not introduced on top of a layer of partly or completely burned fuel, as is the case with hand firing, but moves progressively from the point of entry to the ashpit so that the only available protection is obtained from the ash in the fuel actually undergoing combustion.

The Spreader Stoker

This simple mechanical device for firing solid fuel is enjoying deserved popularity and active demand. If the dearth of available information on troubles is an acceptable indication of satisfactory performance, then this stoker, now in sufficiently widespread use to be representative, is successfully meeting the demands imposed on it. In fact, one of the few difficulties found with this type of stoker is inherent in its ability to meet the demand. Apparently it is so easy to raise the firing rate that there has been found, in some installations, a tendency to raise the firing rate above the capacity of the utilizing equipment to remove the products of combustion. When this is done the furnace pressure becomes positive and the hot gases will escape from the furnace through any available openings. One of these openings is that through which the fuel is introduced and in which the spreader mechanism operates. Hot gases burn the metal of the spreader mechanism under bad conditions or warp it badly under milder conditions of positive pressures in the furnace.

The danger of discharging hot gases through the stoker mechanism can be avoided by automatic control of fuel feed, air supply and furnace draft. In one case repeated instances of trouble arose from the attempt to control these elements by hand. The reason for the difficulty of operating by hand control is the low resistance of thin fuel bed on the grates and the rapid response of the mechanism to a change in adjustment. Some manufacturers prefer not to sell these stokers unless automatic control is provided.

Where spreader type stokers are installed in plants accustomed to hand firing it is sometimes difficult to secure a change in fuel sizing from the large sizes desirable for hand firing to the commercial $^3/_4$-in. nut and slack which is more desirable for the spreader. The feeder mechanism of spreader stokers is designed for the smaller sizes and although it will handle occasional lumps of 2 to 3-in. size the mechanism should not be called upon to act as a coal crusher. The larger lumps have a longer trajectory and will tend to pile up at the sides and back of the grate. Such piling up of the fuel encourages clinker formation which is troublesome with any type of grate and may result in burned metal with some types. The simple easily adjustable controls permit the firemen to place the fuel at the desired point on the grate so that uneven distribution has been corrected by alert firemen in five to fifteen minutes.

If ultra fine coal is used on a spreader stoker more of the fuel is carried in suspension by the combustion gases.

It is obvious that even if the coal size is correct the operator may fail to keep the speed of the spreader adjusted properly so that uneven distribution results. Under such conditions the distributor assembly may be overheated by a heavy fire at the front, and slagging on grates or refractory walls or brickwork erosion may be caused by heavy fires at the sides or rear.

Two Hundred Register at Sixth Annual Fuels Conference

THE first wartime Fuels Conference of the Coal Division, A.I.M.E., and the Fuels Division, A.S.M.E., held to its excellent attendance record of peacetime. The program, built around wartime fuel problems, attracted fuel producers and users from all over the country. Held concurrently with the Regional Meeting of the A.I.M.E., to reduce time and travel, the meeting at St. Louis, Sept. 30–Oct. 1, competed successfully with the opening games of the World Series.

Dr. M. M. Leighton, Director of the Illinois Geological Survey, welcomed the fuel engineers on Wednesday morning, September 30. In an impressive talk he pointed out the obligations of the group in considering the vital fuels supply by proper application and efficient utilization. He was deeply impressed by the benefits to the war effort which could result from such a meeting of the producers and users of this important natural resource. **A. R. Mumford,** Chairman of the Fuels Division A.S.M.E., in responding to Dr. Leighton noted that the high plane of the welcome had impressed the conference and promised that it would insure more complete understanding of mutual problems.

More Metallurgical and Foundry Coke Needed

I. M. Roberts, of the Laclede Gas Light Co. of St. Louis, reported on his experiments which resulted in the substantial revolution of the coking time for foundry coke without impairment of quality. He had found that the addition of about 5 per cent of small-sized anthracite from certain mines permitted a 19-hr coking time and produced a thoroughly satisfactory foundry coke. Some doubt exists as to the suitability of such combination cokes for blast furnaces, because to date the use of such fast cokes has resulted in burned-out tuyères due to the size degradation of the anthracite cokes in the blast furnaces.

W. T. Brown, Research Engineer of the Jones & Laughlin Steel Corporation, told of a plan of research he had arranged for testing and control of supply which would insure a sufficient supply of satisfactory cokes to the blast furnaces and help them to make more iron. In an extensive analysis of the available coals and the coking qualities of these coals, he pointed out those best suited for blast-furnace use. He felt that such coals should be reserved for the steel industry and that the Bureau of Mines should undertake to determine the swelling properties of coals in coke ovens and the results of blending.

Utilization Session

Successful treatment of coals from an Illinois field to alter the properties of the ash and make the fuel satisfactory in use was reported on by **R. S. Weimer** of the Northern Illinois Coal Corporation. This was presented by **Ralph A. Sherman** in the author's absence. Mr. Weimer had studied the specific gravity of the ash from the coal in the various parts of the field and tabulated the results at a standard reference temperature of 2600 F. From other studies he had determined the effect on density or the addition of materials such as lime or silica. He observed that the same slag densities would not produce satisfactory results in all furnaces and had successfully arranged a treatment program involving 250,000 tons of coal yearly to give the user the kind of fuel suited to his equipment. It was pointed out in the discussion that the time element which controlled the release of gas bubbles in the highly viscous slags, and thus affected the density, was covered by the observation of the furnace conditions. These observations included the time element and set the treatment.

Some common reasons for the burning of stoker iron on six types of stokers were pointed out in a paper by **A. R. Mumford** of Combustion Engineering Company. The necessity for keeping the air passages free to retain the cooling power of the air and for keeping some air flow at low or banked loads until the fire had cooled sufficiently was covered and the effect of clinker and fuel bed contour on air distribution was discussed.

Harmon C. Ray, of the Carter Coal Company, described the collection, distribution by tank car and sale of dust collections at the mine tipple. This experimental development has successfully abated the dust nuisance at the tipple and prevented the re-entry of the dust into the markings where it would constitute an added hazard. The dust is used in the pulverized-coal-fired plants of four nearby utilities using direct-fired mills.

Presentation of Percy Nicholls Award

On Wednesday evening the Fuels Conference held its Annual Dinner which, this year, was the occasion of the first presentation of the Percy Nicholls Award. A. R. Mumford opened the festivities with the introduction of Julian E. Tobey, Director of the Coal Bureau of the Upper Monongahela Valley Association. Mr. Tobey traced the history of the establishment of the award and read Mrs. Nicholls' letter to the group. He then introduced the recipient, **E. G. Bailey,** Vice-President of the Babcock & Wilcox Co. who was presented with the framed scroll by President McAuliffe of the A.I.M.E. In his response to the presentation, Mr. Bailey summed up the progress in the utilization of fuel and asked thoughtful consideration of the limitation of liquid fuels to those purposes to which they were uniquely suited such as maritime and naval service. He warned against the fallacious reasoning of unlimited supply and suggested that rationing will require the selection of those plants operating at high efficiency for preferential consideration as has already occurred in England, normally an exporter of solid fuels.

Supplementary Fuel Supply

On Thursday morning two papers recording the status of experiments using supplementary fuels were presented to the Conference.

A. L. Crain, of the Kansas City Power & Light Com-

pany, reported on the use of gas in combination with stoker-fired coal. Gas, available because of low-load conditions on the gas system, is burned in the stoker-fired furnaces at two levels, one at the throat between the arches above the stoker and the other in the upper furnace at the superheater zone. No loss in monthly efficiencies was noted despite the higher water vapor loss from the gaseous fuel. The superheat averages about 15 deg F higher and led to the use of the upper burners for superheat control when the gas supply becomes restricted.

Dr. W. C. Schroeder, of the U. S. Bureau of Mines, presented a widely discussed report on his examination of the possibility of easing the oil shortage on the Eastern Seaboard by adding pulverized coal to oil and burning it with oil-firing equipment. Although little question was raised about the possibility of producing a stable mixture, the fuel engineers as a whole felt that the combustion of the mixture in burners designed for oil alone would be accompanied by difficulties which might more than nullify any gains which might appear possible in the absence of actual experience in utilizing such mixtures. Many of the engineers felt that the ash problem would be paramount. In the presence of this emergency it was admitted that economic considerations or preparation and distribution should not be considered as governing.

The Fuels Conference and the Regional Meeting held a joint luncheon to listen to President Louis Ware of the International Minerals and Chemical Corporation describe his extensive experience in many different mines in North and South America. His description of the "Shangri Las" hidden in the Andes brought many of his audience to the point of inquiring about transportation.

Mine Priorities and Equipment Problems

Dr. D. L. McElroy, Chief of the Mines Section of the W.P.B., reported on the whole-hearted cooperation of the mining industry with the restrictions on materials supply imposed by the emergency. It was evident that Dr. McElroy's familiarity with the industry led to an understanding in the handling of essential requests which encouraged cooperation. The audience expressed satisfaction with the fairness of the treatment received even though many requests had been refused.

Possible changes in furnace design and equipment arrangement in conversion problems were discussed by **Ollison Craig** of the Riley Stoker Corporation. The ingenious use of available space and modification of design made possible successful conversions in the illustrations presented.

A. Lee Barrett of the Pittsburgh Coal Company told the audience of the way in which mine machine shops were utilizing equipment to aid in war production.

Secretary Ickes Speaks on Conservation

At the joint banquet on Thursday evening Secretary Ickes addressed the Conference on the subject he described as his lifelong hobby, "Conservation." He urged revision of the law in some states to prevent the wastefully rapid development of natural resources which although resulting in a temporary production record, finally locked in the ground resources which might have remained available under more orderly conditions of development.

REVIEW OF NEW BOOKS

Any of the books here reviewed may be secured through Combustion Publishing Company, Inc., 200 Madison Ave., N. Y.

A First Course in Mathematics

By Edward Baker

In a field so thoroughly worked and reworked, originality of treatment is not to be expected. The test of a textbook lies in its practical use in schools and colleges, and teachers will recognize in this book by Edward Baker of Newark College of Engineering an excellent medium of mathematics instruction compiled to meet the needs of students of engineering and the physical sciences.

The book follows the traditional plan of proceeding from less difficult to more difficult subjects and the study of analytic geometry is postponed to the latter part of the book. The increasing importance of vector concepts in pure and applied mathematics has prompted the author to place a greater degree of emphasis upon vector ideas than is customarily accorded in an elementary textbook, with the result that a simpler and more direct approach is possible to certain topics. The scope of the work may be ascertained by the fact that a chapter on the calculus is included.

A First Course in Mathematics contains 22 cogently written and adequately illustrated chapters. The topics contained in each chapter are subdivided into pertinent sections, most of which are followed by numerous exercises relating to the subject discussed. The book contains 295 pages, size 6×9, and includes a 5-page index. It is bound in dark brown buckram and the inside cover pages are devoted to useful formulas for ready reference. Price $3.00.

How to Read Electrical Blueprints

By Gilbert M. Heine and Carl H. Dunlap

The electrical industry has many branches and, because of the diversified nature of the work performed and the equipment used, each branch uses a type of blueprint and certain symbols designed to meet its own particular needs. For this reason, and to avoid confusion in the mind of the reader, the text of this book is divided in sections, eight of which deal with different branches of the electrical industry.

Following a brief section on the making of blueprints and the principles involved in laying out a drawing, the reader is introduced to the subject—How to read architectural blueprints; and in the sections that follow: How to read: diagrams for bell and signal wiring; house wiring blueprints; administration building blueprints; automobile wiring diagrams; diagrams of generators and motors; symbols for control diagrams; motor control diagrams; and power station blueprints. Each section is supplemented with an informative list of questions and answers and a set of "quiz" questions designed to test the reader's knowledge of the subject discussed. The book is admirably illustrated with many line cuts and halftones and, where symbols are presented, each symbol is accompanied by a pictorial sketch of the object or equipment indicated. The book also contains a comprehensive 12-page index and a set of nine instructive blueprints in a back cover pocket.

The book comprises 318 pages, size $5\frac{1}{2} \times 8\frac{1}{4}$, bound in blue cloth. Price $3.00.

Guidance Manual for Engineers

The Engineers' Council for Professional Development has prepared and published a pamphlet entitled "Manual for Committees of Engineers Interested in Engineering Education and the Engineering Profession." This 16-page manual offers suggestions regarding the organization of advisory committees to aid high school students in choosing their vocation and studies, and provides a general outline of procedure. Accompanying the Manual is a separately printed 8-page Appendix addressed to the student, comprising a questionnaire designed to supply the committee or counselor with the biographical and educational background of the student.

The Manual with Appendix may be obtained from E.C.P.D. Headquarters, 29 West 39th Street, New York, N. Y., at 10 cents per copy; copies of the Appendix only, 5 cents.

Ripper's Heat Engines (New Edition)

Revised by A. T. J. Mersey

The continued popularity of this textbook is evidence that its broad scope and concise treatment satisfy the needs of a large number of students. This new American edition follows the most recent English edition by the omission of obsolete matter and by the inclusion of revisions and additions to bring the book into line with present practice.

The fundamental principles of heat and energy are discussed in the opening chapters and the main applications of these principles to reciprocating steam engines in those that follow. Considerable attention is given to component parts, auxiliaries, boilers and the combustion of fuel, while the concluding chapters deal with steam turbines and internal combustion engines. Explanations are clearly expressed and all necessary calculations are included in the text. Numerous exercise problems are given at the end of the book.

The book is admirably illustrated with 226 drawings and charts. It contains 337 pages, size $5 \times 7\frac{1}{2}$, and includes a 3-page index. Bound in red buckram. Price $1.60.

Plane Trigonometry Made Plain

By Albert B. Carson, Ph.D.

This book deals with the fundamentals of plane trigonometry in greater detail than is done in most texts, and the discussions are presented in such a manner—accompanied by an unusually large number of figures and illustrative examples—that the student is enabled to comprehend how and why the principles are employed, and their practical application.

Beginning with definitions and principles of triangles, the subject is developed in eleven chapters to include inverse trigonometric functions and trigonometric equations. Most of the chapters conclude with pertinent questions and answers, a brief summary of the chapter and many practice problems. The remainder of the book is devoted to logarithmic and trigonometric tables and a very complete 5-page index. The work contains 389 pages, size $5\frac{1}{2} \times 8\frac{1}{4}$; bound in blue cloth. Price $2.75.

The Steam Locomotive

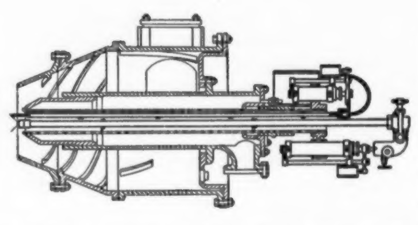
on order

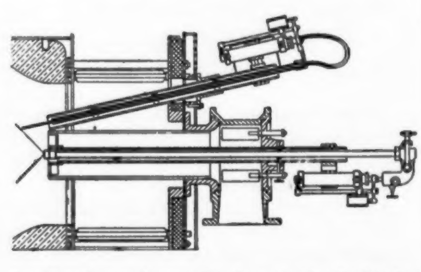
By Ralph P. Johnson

Ralph P. Johnson, Chief Engineer of the Baldwin Locomotive Works, has in this book met the need of a modern work on the theory and practice of the steam locomotive. He has gathered a great deal of factual material from authoritative sources and in *The Steam Locomotive* this information is presented in a convenient and accessible form.

Some of the subjects dealt with in the first few chapters include Fuels, Combustion, Boiler Water, Evaporation and Superheat, and these are followed by others dealing with Tractive Force, Horsepower, Resistance and Tonnage Rating. Subsequent chapters deal with Curves, Valve Gears and Valve Setting, Acceleration, Testing, Dynamometer Cars, High Speed Trains and also Streamlined and Light Weight Trains. A chapter on Motive Power for High Speed Service introduces the Diesel engine, and in the next, pertaining to Switching Service, a comparison is made between steam and Diesel locomotives. Two chapters deal with the economic aspects of operation and repairs and the final chapter with the economic life of locomotives.

The book contains 71 tables and 83 line-cut drawings and charts. Six drawings of indicator reducing motions are included in a back cover pocket. The work comprises 502 pages, size $6 \times 9\frac{1}{4}$, and includes a bibliography and an 8-page index. Bound in black buckram. Price $3.50.





A Swiss View on Hydrogen Cooling

The issue of the *Brown Boveri Review*, covering the first quarter of 1942, has lately reached this side of the Atlantic and is devoted to progress in 1941. With reference to hydrogen cooling for large turbine-generators it offers the following comments:

"Today, the losses in turbine generators of the 50- to 60-mva (60,000-kw) output range hardly exceed 1.5 per cent at full load. It would seem feasible to attain as much as 99 per cent efficiency for big air-cooled turbine-generators, by eliminating other sources of losses, chiefly in reducing air friction by giving more attention to aero-dynamic principles. Thus, the application of hydrogen gas to cooling would hardly seem worth while, at least for generators of the above output range, and the gains achieved thereby would appear in no way to compensate for the constructive complications implied. As, however, it is to be expected that there is a demand coming for bigger outputs per unit on account of the high level of coal prices, a phenomenon which marked the period following the last World War, and as hydrogen cooling may be advantageous in these cases, we devoted considerable study to the problem, the most difficult factor of which is that of effective sealing. One of the results of these studies has been the development of a gland which, contrary to complicated American designs, allows of perfect shaft sealing. We were assisted in this task by having available a sealing-gland design which we had developed some years back for our Frigiblocs driven by steam turbines or d-c motors, as well as for blowers for handling gas and vapours and which had proved most efficient. The oil losses registered with this gland were less than one per cent of those of American sealing-gland designs and we are in hopes of even reducing this figure."

Personals

M. D. Engle, Assistant Superintendent of Engineering of the Boston Edison Company, is now serving with the War Production Board in Washington, D. C.

Elmer L. Lindseth, for several years past production engineer and assistant to the president of the Cleveland Electric Illuminating Company, has been elected vice-President of that company. He has been associated with the company almost continuously since graduation in mechanical engineering from Yale in 1926.

H. L. Watson, since 1934 Executive Vice-President of De Laval Steam Turbine Company, has been elected to the presidency of that company, succeeding Francis J. Arend, lately deceased.

L. F. Richardson, has been appointed branch manager of the newly established Los Angeles office of Bailey Meter Company, and H. T. Sawyer has been made manager of that company's Seattle Office.

EQUIPMENT SALES

as reported by equipment manufacturers to the Department of Commerce, Bureau of the Census

Boiler Sales
Stationary Power Boilers

	1942 Water Tube		1941 Water Tube		1942 Fire Tube		1941 Fire Tube	
	No.	Sq Ft*	No.	Sq Ft*	No.	Sq Ft	No.	Sq Ft
Jan.	202	1,637,588	170	968,275	53	61,990	89	123,459
Feb.	238	1,557,004	97	847,331	59	84,660	81	104,622
Mar.	273	1,520,654	138	988,037	166	92,999	86	89,324
Apr.	430	2,441,668	159	802,993	57	81,402	129	151,636
May	‡160	‡1,280,558	134	850,659	63	‡90,069	114	154,964
June	139	847,562	141	743,762	61	75,831	114	134,880
July	134	891,224	184	1,184,984	48	56,996	94	121,884
Aug.	112	928,440	113	749,405	26	30,228	51	101,284
Jan.-Aug. Incl.	1,688	11,104,698	1,136	7,135,446	533	574,175	758	982,053

* Includes water wall heating surface. ‡ Revised.

Total steam generating capacity of water tube boilers sold in the period January to August (incl.) 1942, 94,055,000 lb per hr; in 1941, 73,285,000 lb per hr.

†Mechanical Stoker Sales

	1942 Water Tube		1941 Water Tube		1942 Fire Tube		1941 Fire Tube	
	No.	Hp	No.	Hp	No.	Hp	No.	Hp
Jan.	87	42,876	77	41,975	‡154	‡23,550	94	14,036
Feb.	131	55,001	60	27,736	185	26,889	117	14,774
Mar.	84	46,055	69	31,342	212	‡31,715	146	21,552
Apr.	‡102	‡49,061	75	34,832	313	39,877	147	20,555
May	125	44,069	90	43,971	206	33,566	144	19,267
June	123	48,267	136	50,896	296	49,760	264	42,619
July	131	59,376	113	50,108	297	45,902	290	40,943
Aug.	94	40,619	96	41,882	295	49,725	391	49,547
Jan.-Aug. Incl.	877	385,324	716	322,742	1,958	300,984	1,593	223,293

† Capacity over 300 lb of coal per hr. ‡ Revised.

Pulverizer Sales

	1942 Water Tube			1941 Water Tube			1942 Fire Tube			1941 Fire Tube		
	No. (N)	No. (E)	Lb Coal/hr	No. (N)	No. (E)	Lb Coal/hr	No. (N)	No. (E)	Lb Coal/hr	No. (N)	No. (E)	Lb Coal/hr
Jan.	102	3	1,071,340	39	—	462,990	—	—	—	—	1	1,000
Feb.	21	1	246,520	42	4	734,200	—	—	—	—	—	—
Mar.	31	7	360,620	31	3	739,700	1	—	13,300	—	—	—
Apr.	49	8	845,740	14	8	225,740	—	—	—	1	—	2,800
May	‡26	4	‡373,962	54	10	777,320	—	—	—	—	4	7,000
June	24	3	323,500	28	24	523,540	—	—	—	—	1	1,000
July	21	11	300,880	57	7	828,640	—	—	—	—	1	600
Aug.	3	12	180,460	30	5	456,480	—	—	—	—	1	800
Jan.-Aug. Incl.	277	49	3,703,022	295	61	4,748,610	1	—	13,300	1	8	13,200

(N)—New Boilers; (E)—Existing Boilers. ‡ Revised.

(*Continued from page 39*)

other parts. Their inspection should include checking the elements for alignment and evidence of warping or bulging; checking supports, spacers, baffling and seal plates; examining joints for tightness; noting the condition of internal and external surfaces; and checking the location, alignment and condition of the soot blowers.

Although examination of a part that has failed will usually indicate the cause, such knowledge may be gained at the cost of valuable time and capacity, in addition to the expense involved. It is therefore important to institute such measures of inspection and check-up, as a part of the regular operating routine, as will detect impending trouble in time to prevent failures and consequent unscheduled outage.

Incidentally, it may be pointed out that while the performance and service of a superheater depend largely upon the proper functioning of other parts of the unit, particularly the fuel-burning equipment and furnace, the superheater is about the only part of a steam generating unit whose performance is closely related to the operation of the prime mover.

NEW CATALOGS AND BULLETINS

Any of these publications will be sent on request

Bearing Metals

The Magnolia Metal Company has issued an 8-page illustrated bulletin which describes various lead-base metals that can be used as substitutes for tin-base bearing metals. The bulletin contains recommendations for selecting the correct type of bearing metal for 135 different types of machinery and includes a number of practical suggestions in making and maintaining journal bearings. Isotropic die-cast bronze bushings, from 1 to 9-in. O.D., are also described.

CO_2 Analyzer

The Bacharach Industrial Instrument Company has issued a 4-page bulletin (No. 338) which describes its portable Fyrite CO_2 Analyzer. Illustrations and text show the simplicity of taking readings with this instrument. Also described is the Fire Efficiency Finder, a pocket calculator provided with the set that converts CO_2 and stack temperature readings into heat loss and heating efficiency percentages.

Care of Rubber V-Belts

The Allis-Chalmers Manufacturing Company has issued a 16-page illustrated booklet entitled "Plain Facts on Wartime Care of Rubber V-Belts." On the assumption that thousands of workers in war industries are unfamiliar with the subject of maintenance, this handbook begins with the anatomy of a V-belt and principle of the V-belt drive, shows how anatomy affects maintenance, how to obtain proper tension, what to do about worn sheaves, etc., and ends with post-mortems on actually damaged V-belts.

Dust Recovery

A very attractive and informative booklet entitled "The Buell van Tongeren System of Industrial Dust Recovery" has just been issued by the Buell Engineering Company. This 28-page publication explores the major problems of dust recovery and suggests practical methods for their solution. Particular attention is given to the utilization of the "double eddy current" phenomenon in cyclones to actually increase collection efficiency in Buell (van Tongeren) installations. Illustrations are admirable and include: cut-away views, photographic assembly and installation views, and blueprint diagrams showing the applications of the system to a wide range of industrial uses. Typical applications to stoker-fired and pulverized-fuel fired boilers are also given.

Heat Transfer Through Metallic Walls

The International Nickel Company has issued a 20-page booklet entitled "Heat Transfer Through Metallic Walls" compiled from data prepared by the Company's Development and Research Division. The text includes information in formulas for determining overall heat transfer rates, the various factors influencing heat transfer through metallic walls, and the thermal conductivities of metals and alloys commonly used in the construction of process equipment. Numerous illustrations show types of process units that depend on the transfer of heat through metallic walls for their normal operation. Eleven charts showing the effect of wall thickness on heat transfer through different metals and alloys are also given.

Machine Tool Accessories

An 8-page illustrated bulletin has been received from the Ideal Commutator Dresser Company describing its line of Ideal machine tool accessories. These include: live centers, metal etcher, demagnetizer, grinding wheel dresser, balancing ways, variable-speed pulleys, electric marker and portable cleaners.

Opposed Impeller Pumps

Two-stage centrifugal pumps of the opposed impeller design are described in a 12-page illustrated catalog (B-3) issued by the De Laval Steam Turbine Company. In this type of pump, both impellers are of the single-suction type. The suction openings face outwardly so that axial thrust is balanced. Both suction and discharge nozzles are in the lower half of the casing and all parts of the pump are accessible and can be removed by lifting the casing cover. This type of pump is listed for capacities ranging from 50 to 1500 gallons per minute, and for heads from 80 to 800 ft.

Water Softeners

Worthington Pump and Machinery Corporation has issued a 6-page folder (Bulletin W-212-B2) describing its hot process water softeners. A large blueprint diagram shows the Worthington hot lime soda softener, deaerating type, and its special features are described in the accompanying text. Numerous halftone illustrations are given showing pumps, tanks and other water softening equipment.

Synthetic Fuels in Germany

In view of the drive of the Germans toward the Russian oil fields, the following excerpts from a recent communication of B. B. Williams, President of The Cooper-Bessemer Corporation are of interest:

"On my last visit to Germany, I had the opportunity to investigate the production of diesel engines and the manufacture of fuels. Thousands of diesel engines were being constructed in Germany, even then, for installation in tanks, trucks, tractors, trains and airplanes. In Germany, the diesel aircraft engine is a reality and thousands of Hitler's planes are thus powered. This application of the diesel engine principle to the German war machine has resulted in tremendous saving of fuel—and has upset the calculations of many 'experts.'

"By the beginning of 1939, a tax of 51 cents a gallon had been imposed in Italy on gasoline and a 36 cent tax in Germany. The reason was to encourage the development of synthetic and substitute fuels. There also were direct subsidies. At that time, about one-quarter of all motor vehicle transportation in the Axis countries was accomplished with synthetic or substitute fuels.

"Gasoline made from coal gases was widely used. Alcohol made from vegetables was blended with straight gasoline. There were experiments with ammonia and acetylene. Some 25,000 vehicles in Europe used compressed gases as fuel. The German motorist, who had to pay 60 cents a gallon for gasoline, could use city gas at a price equivalent to 43 cents a gallon. Forty-one cents worth of methane also took him as far as a gallon of gasoline. Propane-butane fuel was more expensive—equivalent to 61 cents a gallon—but one tank full took the motorist some 225 miles.

"Other substitutes for gasoline and oil are oil made by hydrogenation, pulverized coal suspended in oil and oil 'cooked' from corn, wood, algae, seaweed, leaves and similar substances in combination with limestone.

"It is logical to assume that the rapid growth of synthetics and substitutes in Germany has been accelerated by the war."

Advertisers in This Issue

Air Preheater Corporation, The.... 9
American Blower Corp.......20 and 21
Bacharach Industrial Instrument Company.... 54
C. O. Bartlett & Snow Company, The.... 15
Botfield Refractories Company.... 54
Buell Engineering Company, Inc.. 8
Builders-Providence, Inc.... 27
Philip Carey Mfg. Company, The.. 53
Combustion Engineering Company, Inc......Second Cover, 6 and 7
Crosby Steam Gage and Valve Company.... 28
Dampney Co. of America, The.... 10
Diamond Power Specialty Corp.... Third Cover
Davis Regulator Company.... 50
De Laval Steam Turbine Co..42 and 56
Edward Valve & Mfg. Co., Inc..... 5
Elliott Company.... 48
Engineer Company, The.... 52
Exposition of Power & Mechanical Engineering, 15th National...... 53
General Coal Company.... 18
General Electric Company...12 and 13
Globe Steel Tubes Company.... 23
Hagan Corporation.... 17
Hall Laboratories, Inc.... 17
Infilco Incorporated.... 14
Koppers Coal.... 4
Midwest Piping & Supply Co.... 11
Northern Equipment Co.... 2
Plibrico Jointless Firebrick Co..... 56
Poole Foundry & Machine Co.... 47
Prat-Daniel Corporation.... 3
Refractory & Insulation Corp...... Fourth Cover
Reliance Gauge Column Co., The. 53
Research Corporation.... 26
Sauerman Bros., Inc.... 56
Steel and Tubes Division, Republic Steel Corporation.... 25
Stock Engineering Co.... 55
Terry Steam Turbine Company, The.... 22
Thermix Engineering Co.... 19
Union Asbestos and Rubber Co.... 24
Yarnall-Waring Co.... 16